THE FOLLOWING PAGES WERE NOT RECEIVED WITH ORIGINAL DOCUMENT AND THEREFORE HAVE NOT BEEN REPRODUCED:

Appendix A, p.p. A-13 to A-15

PUISQUE LES PAGES SUIVANTES N'ONT PAS ÉTÉ REÇUES AVEC LE DOCUMENT ORIGINAL ELLES N'ONT PAS ÉTÉ REPRODUITES:

CMHC FILE NO. 6550-18

DETAILS FOR AN EVOLVING WOOD FRAME CONSTRUCTION

FINAL REPORT

PREPARED BY: ALLEN-DRERUP-WHITE LTD.
334 KING STREET EAST
SUITE 505
TORONTO, ONTARIO
M5A 1K8
(416) 863-1762

AND THE ETA GROUP

SUBMITTED DECEMBER, 1984

ACKNOWLEDGEMENTS

Well over 160 people have contributed to this study. Those who completed the mail out survey spent considerable time getting information and drawings; without their, unremunerated, efforts this study would have been impossible. Particular thanks are owing to the following individuals who were singled out for indepth interviews or who otherwise gave us special assistance: John Carroll, Carroll Homes, Alan Gandeil, Truss Plate Institute of Canada, Rick Hiebert and Gay Burns, Manitoba Housing & Renewal Corporation, John Hughes, Passive Solar Designs, John Larsen, Sunscape Builders, Warren Jones, Cortez Energy Efficient Homes, Willis Graham, Enco Developments, Ryan Litchfield, Cascade Energy Homes, Nick Shymko, Flair Homes, Bill Small, Glen Leven Properties, Henry tenDen, Canadian Home Builders Association, Mils Wennerstrom, Ekman.

The interim report upon which this final report is based was reviewed by many leading authorities including representatives from CMHC's Technical Research Division, NRC's Division of Building Research, University of Waterloo's Building Engineering Group, University of Toronto's Department of Building Science and several private consultants. Their comments have been incorporated and were vital in shaping this final report. However, any errors or omissions remain the responsibility of the project team.

Finally, we would like to thank the C.M.H.C. project co-ordinator, Fanis Grammenos, for his patience and guidance.

The project team:-

ALLEN-DRERUP-WHITE LTD.	Greg Allen Paul Kerman Elizabeth White
RENEWABLE ENERGY IN CANADA LTD.	Robert Argue Brian Marshall
SOLAR APPLICATIONS & RESEARCH	Chris Mattock
SUNRIDGE RESIDENTIAL	Keith Hanson
DRAWINGS BY	Roland Rom Colthoff

TABLE OF CONTENTS

			PAGE
SECTION 1	1.0	INTRODUCTION	1
	2.0	ORGANIZATION OF THE REPORT	1
	3.0	STANDARDS FOR ENERGY EFFICIENCY	1
	4.0	TECHNICAL PERFORMANCE OF THE BUILDING ENVELOPE	4
		General Considerations and Recent Understandings	4
		Foundation Walls and Basement Slabs	6
		Above Grade Walls and Headers	7
		Roof Spaces	8
	5.0	PRACTICAL APPLICATIONS	9
		Materials and Labour Costs	9
		Trade Acceptance	9
		Forgiveability	10
		Flexibility	10
	6.0	SUMMARY FINDINGS AND RECOMMENDATIONS	10
SECTION 2		THE DRAWINGS	
		THE CODING	14
		GRAPHIC CONVENTIONS	16
		ASSUMPTIONS FOR NOMINAL RSI VALUES	16
		ASSUMPTIONS FOR EFFECTIVE RSI VALUES	16
		SUMMARY OF DRAWINGS	19
		SINGLE FRAME WALLS WITH INSULATED SHEATHING:	20
		AGW 11 Exterior Sheathing with Polyethylene A.V.B.	21
		AGW 12 Two Layers of Exterior Sheathing	41
		AGW 13 'Drywall' Systems	49
		AGW 14 Interior Insulated Sheathing	61
		SINGLE FRAME WALLS WITH INTERIOR STRAPPING:	67
		AGW 21 Using 38 x 64 mm Strapping and Insulated Sheathing	68
		AGW 22 Using 38 x 38 mm Strapping and Insulated Sheathing	84
		AGW 23 Using 38 x 64 mm Strapping and Conventional Sheathing	92

TABLE OF CONTENTS (cont'd)

			PAGE
SECTION 2 (cont'd)			
		THICK WALL - DOUBLE FRAME SYSTEMS:	112
	AGW 51	Interior Wall Loadbearing	114
	AGW 52	Interior Wall Loadbearing Variation	130
	AGW 53	Exterior Wall Loadbearing	134
	AGW 54	Exterior Wall Loadbearing Variation	146
		THICK WALL - STANDOFF SYSTEMS:	154
	AGW 61	Manufactured Standoff	155
	AGW 62	Site Built Standoff	169
	AGW 63	Site Assembled System Using Metal Channel	173
		THICK WALL - EXPANDED STUD SYSTEMS	175
	AGW 71	Plywood Gusset Truss	176
	AGW 72	Metal Web Truss	186
		ROOF SYSTEMS	194
	RF 31	Raised Heel Truss	194
	RF 32	Dropped Cord Truss	194
	RF 33	Sloped Ceiling - Scissors Truss	194
	RF 34,35	Sloped Ceiling - Parallel Cord Truss	194
	RF 37	Rafters with Ceiling Joists	194
	RF 38	Rafters with Purlins	194
		PENETRATIONS AND OPENINGS	204
		Pipes and Vents	205
		Electrical	213
		Windows and Doors	221
APPENDIX	A	COMPUTER AIDED DRAFTING STUDY	
	B	QUESTIONNAIRE FINDINGS	

SECTION 1

1.0 INTRODUCTION

This report forms the final part of a study to assemble and evaluate evolving wood frame construction details which was undertaken in 1984. The drawings included here document the methods used by the construction industry to improve the thermal envelope performance of platform frame housing; all drawings were contributed by builders and illustrate techniques which they had used in the past and intended to use again. The purpose of this report is to inform builders and researchers of the wide variety of techniques in current use so that they may better adapt, refine and test these techniques. The intent is not to approve or reject, either explicitly or implicity, any of the systems illustrated, although it is hoped that the details assembled here together with the accompanying commentaries will speed the development and dissemination of sound, energy efficient construction practice.

2.0 ORGANIZATION OF THE REPORT

Section 1 precedes the detail drawings and contains a summary of the technical and practical issues raised by the drawings. Findings and recommendations have been included at the end of Section 1.

Section 2 begins with an explanation of the assumptions and conventions used for the drawings. The details have been classified according to above grade wall type and have been divided into five major systems:

- single frame with insulating sheathing
- single frame with interior strapping
- double frame
- standoff systems
- expanded stud systems

Within each system there are several variations giving a total of fifteen documented wall types. The drawings of each major system begin with a full wall section and discussion of the system characteristics. The details following the section drawing are organized sequentially from sill to eave. Each drawing is accompanied by a brief commentary. Variations may or may not include a full wall section and are also organized sequentially.

This report contains two major appendices, Appendix A is a computer aided drafting study and Appendix B contains the methods and questionnaire findings, the results of the Phase I study.

3.0 STANDARDS FOR ENERGY EFFICIENCY

In recent years there has been a recognition by organizations and individuals involved in development of standards that increased insulation levels and weathertight housing is a desirable goal. The National Building Code (NBC) has reflected this intent but, by definition, is limited to minimum standards of very broad scope. For example, specific insulation levels are not specified, leaving this information to

3.0 STANDARDS FOR ENERGY EFFICIENCY (cont'd)

be supplied by provincial or local codes (e.g. Ontario Building Code, Table 1). As low energy housing evolved in recent years, requiring solutions significantly beyond these minimum NBC criteria, attempts have been made to draw up "voluntary" improved guidelines with a view to significantly reduce energy costs in housing, specifically for space heating. The National Research Council developed the "Measures for Energy Conservation in New Buildings" in 1979, updated in 1983 as a parallel document to the NBC which, if adopted, specifies increased insulation levels (see Table 1) and indicates the intent of increased airtightness. It also draws attention to thermal bridges, building envelope penetration and glazing/door air leakage. It indicates flexibility by allowing individual assemblies to violate the thermal resistance standards as long as the overall building envelope demonstrates an equivalent thermal resistance.

However, it is a brief document and problems of detailing and execution, especially in regards to airtightness, are not addressed. Under the National Housing Act all Canada Mortgage and Housing (CMHC) funded housing is required to abide by the "Measures for Energy Conservation".

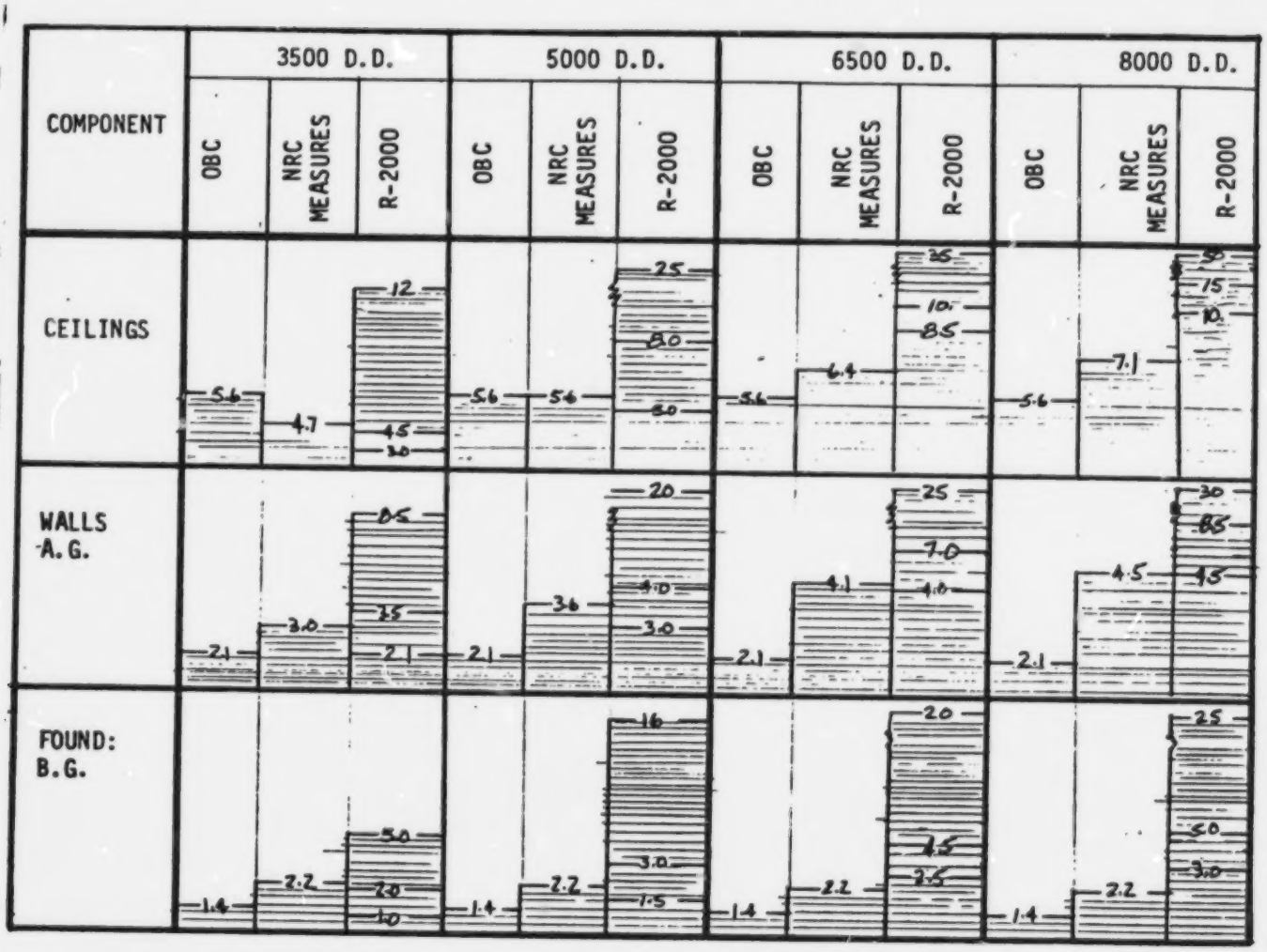
Another approach is being used by Energy, Mines and Resources Canada in association with the Canadian Home Builders' Association (CHBA, formerly HUDAC) in the R-2000 program. House designs must pass a thermal performance standard to be eligible for a builder's grant. The standard relates energy use to house size and type and is compared against results from the performance simulation computer program, HOTCAN, which uses building parameters derived from the drawings and specifications. The intent of the standard is to control the total house energy budget, but basically addresses the space heating requirement. This approach allows for flexibility in design, but nevertheless requires high insulation and airtightness levels to achieve a low energy budget.

Methods of assuring successful compliance to the above performance standard in the field include builder training and airtightness testing.

Table 1 compares insulation levels for the three standards. Note that the efficiency of the ventilation equipment determines the minimum insulation value required in the R-2000 example. Using the example given in Table 1 single frame wall types can meet R-2000 program requirements for climate zones under 8000 degree days provided high efficiency heat recovery ventilation is employed. If no heat recovery equipment is used, thick wall systems must be used in all climate zones.

TABLE 1

A COMPARISON CHART OF INSULATION LEVELS



1 The Ontario Building Code is in force and in large measure a reflection of the current National Building Code.

2 The "Measures 83" are recommendations only and not a standard.

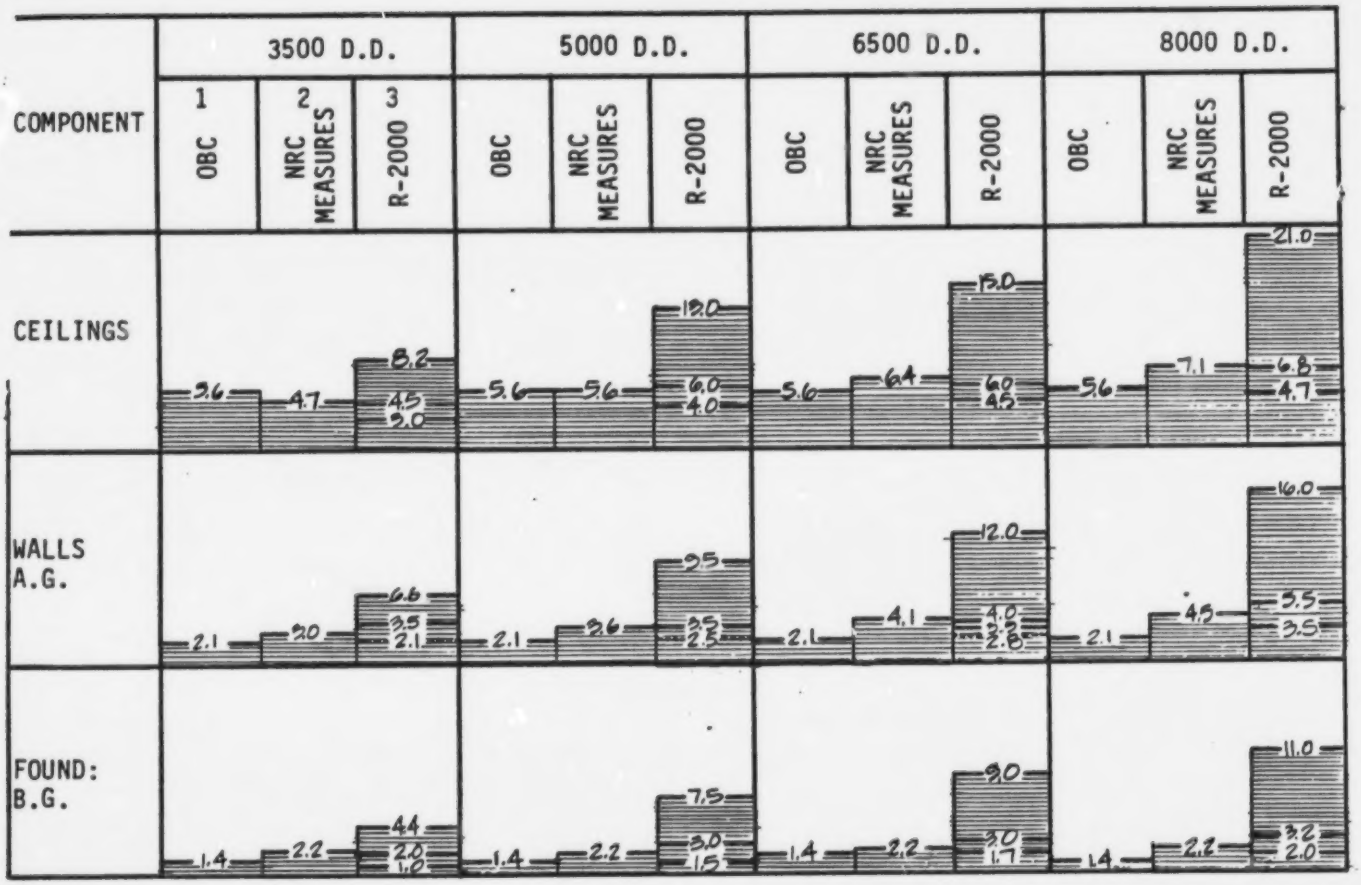
3 R-2000 is a voluntary program with a performance standard. The only prescriptive insulation standard is that above grade walls must be insulated to RSI 3.5 or better. The values used in column three were derived from a series of HOTCAN runs for a two storey energy efficient house designed for CMHC. They represent, approximately, the least values required to meet R-2000 programme requirements under the following assumptions:

Highest value:	No heat recovery ventilation	@ 0%
Mid value :	Heat recovery ventilation	@ 55%
Lowest Value :	Heat recovery ventilation	@ 80%

Note that these results are design specific and should not be applied to other houses.

TABLE 1

A COMPARISON CHART OF INSULATION LEVELS



1 The Ontario Building Code is in force and in large measure a reflection of the current National Building Code.

2 The "Measures 83" are recommendations only and not a standard.

3 R-2000 is a voluntary program with a performance standard. The only prescriptive insulation standard is that above grade walls must be insulated to RSI 3.5 or better. The values used in column three were derived from a series of HOTCAN runs for a two storey 148 m^2 energy efficient house designed for CMHC. They represent, approximately, the least values required to meet R-2000 programme requirements under the following assumptions:

Highest value:	No heat recovery ventilation	@ 0%
Mid value :	Heat recovery ventilation	@ 25%
Lowest value :	Heat recovery ventilation	@ 80%

Note that these results are design specific and should not be applied to other houses

4.0 TECHNICAL PERFORMANCE OF THE BUILDING ENVELOPE

4.1 GENERAL CONSIDERATIONS AND RECENT UNDERSTANDINGS

The building envelope should ensure safe and comfortable living conditions with added considerations of low construction, space heating and maintenance costs. Materials should be durable for their intended use and/or protected, by the application of building physics, from deleterious effects. Many of the buildings, to which the details of this study relate, can be expected to be in existence fifty or more years from today but many of the submitted details contained errors or omissions which if adhered to in the field, could give rise to future problems. It therefore seems appropriate to review briefly the principles which should be applied to each detail.

Structural adequacy must be provided under wind and floor loads. The structural frame should be evident in the details. Complexity can result in errors during the construction process and will make predictions of long-term behaviour more difficult.

The main function of the building envelope, other than to shed precipitation, is to separate the indoor living space from cold winds and cold temperatures in winter. To do this well, high levels of insulation and airtightness are required.

Insulation is designed to reduce conductive heat transfer to a minimum. Heat flows from warm areas or surfaces to cooler ones and thus increases as the indoor-outdoor temperature difference increases. It is resisted by insulation materials as long as they effectively perform their function.

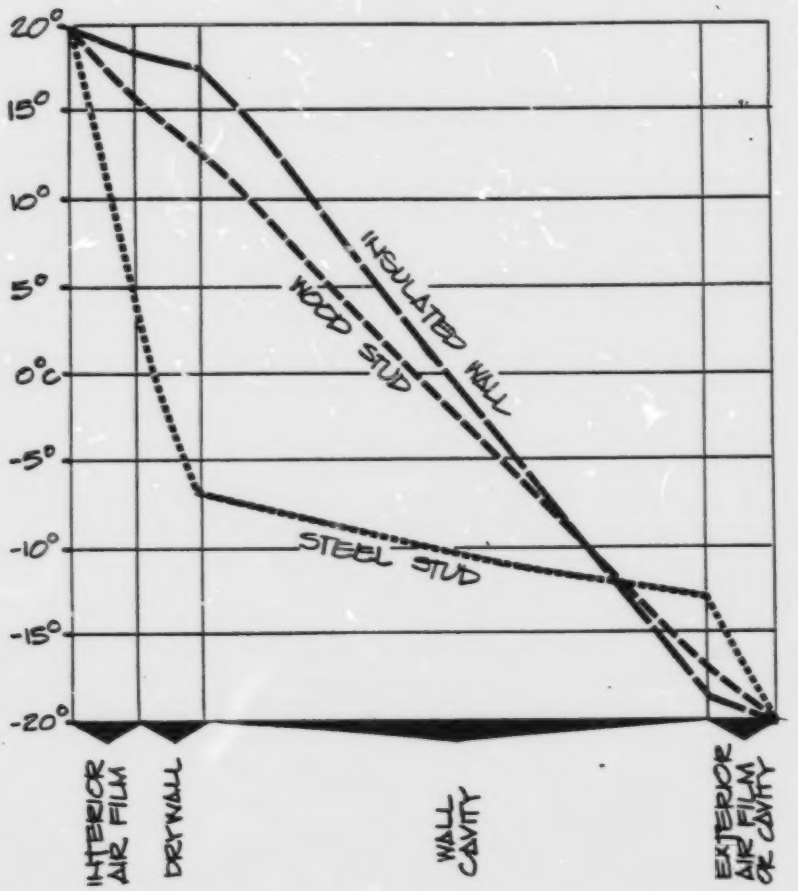
Heat can flow in any direction from warm to cold. Details that have low resistance or high conductivity, such as a metal stud between two insulated cavities, not only have higher heat loss but the interior surface temperature of the drywall is 10°C colder (see Fig. 1). This temperature (about 5°C) would be below the dewpoint at 40% R.H. (i.e. 7°C), thus promoting the formation of condensation, or surface mould. This will lead to damage and/or discolouration of the wall finish. The approximate heat flow resistance of the assemblies shown in the figure are:

	RSI
Insulated wall area	3.65
At wood stud location	1.22
At steel stud location	0.3

Thermal bridges lose heat at a significantly higher rate than their cross-sectional area or their nominal R-value would indicate. In the steel stud example, the "fin effect" of the steel stud flange (width = 1½" only) was considered. In reality, the relatively conductive drywall also participates in the fin effect conducting heat in its plane towards the steel stud flange. This aspect further increases the conduction of the thermal bridge. Insulated sheathing on either or both sides of the wall will greatly reduce the thermal bridging. Good practice minimizes continuous thermal bridges through the envelope.

4.1 GENERAL CONSIDERATIONS AND RECENT UNDERSTANDINGS (cont'd)

FIGURE 1 TEMPERATURE PROFILE ACROSS A WALL



Any airflow through the insulated structure complicates the thermal behaviour. Three common undesirable airflow conditions are:

- Infiltration and exfiltration of air between interior and exterior, causing increased heat load and heating costs. Moreover, when warm moist air exfiltrates into the insulated cavity, condensation will form on the first surface that is below the dewpoint. If moisture is allowed to accumulate, batt insulation can lose a substantial amount of insulation value and deterioration of the structure could occur.

- Passage of air from outside through the insulated cavity, causing increased heat loss and interior moisture damage. If cold air can pass through insulated spaces and back to outside the insulation value is short-circuited especially if it is air permeable, such as batt insulation. Air gaps between layers of rigid insulation are susceptible to the same problem. This condition may occur at the eaves if there is no air barrier to prevent wind 'blow through' which chills the interior finish. If surface temperatures consistently fall below the dewpoint of the interior air, condensation and mould growth will result. This condition may also occur in wall cavities in which there is constant air movement.

4.1 GENERAL CONSIDERATIONS AND RECENT UNDERSTANDINGS (cont'd)

- Movement of air by convection within a wall cavity, causing increased heat loss. This condition occurs when insulation is improperly installed in a cavity leaving vertical channels around framing members. Thick wall assemblies tend to be more susceptible because of their design.

Designers and builders of low energy houses have sought to solve the problem of air exchange and blowthrough with air barriers. An airtight membrane is usually installed near the interior wall or ceiling surface to minimize the infiltration/exfiltration mechanisms. Another air barrier is usually installed beneath the exterior cladding of walls to maintain the effectiveness of the insulation.

A vapour retarder near the interior wall or ceiling surface (i.e. at a location warmer than the dew point) is also required. Often the sealed interior air barrier also functions as the vapour retarder, as with air-tight polyethylene film. If the air barrier and vapour retarding membrane are properly detailed, a rule of thumb can be used: up to one-third of the insulation value may be on the warm side of the vapour retarding surface.

Some water vapour will find its way into the insulated cavity. The two major mechanisms for moisture removal are by diffusion/convection and gravity drainage. For the former to occur the exterior sheathing or air barrier should be ten times as permeable as the interior vapour retarder. For the latter, the wall should be designed so that water may drain freely from the wall and be directed away by flashings.

4.2 FOUNDATION WALLS AND BASEMENT SLABS

The foundation wall is subjected to soil pressure as well as wind and floor loading and must be restrained at the top by the floor system. The common detail for concrete walls is a 38 x 89 mm sill plate connected by anchor bolts at 2.5 m O.C. The sill plate is in turn fastened to the floor joist system. Preserved wood frame basements rely on a stiff assembly (usually double wood plates) at the top of the wall which is attached to the floor assembly for lateral support.

The foundation wall experiences a complex thermal environment. Above grade it is exposed to the same exterior conditions as the rest of the structure. Below grade it is thermally moderated but requires exterior moisture protection. The cool basement wall in summer causes additional thermal problems as noted below.

Exterior insulation, if properly detailed, will keep the basement wall warmer, thus reducing the relative humidity and the driving force of water vapour into the wall. The insulation also provides physical buffering against soil pressures and possible adfreezing forces. A draining insulation can be

4.2 FOUNDATION WALLS AND BASEMENT SLABS (cont'd)

used to increase moisture protection, and, if integrated with perimeter drainage, can eliminate the need for special well-draining backfill. However, even if good drainage is ensured moisture protection to grade is required as the water table may rise for short periods of time (e.g. during spring run-off).

Some designers have used insulation under the footing to raise its temperature and reduce heat loss. This detail can also be beneficial as dampproofing. However, care must be taken to ensure that the area of the footing is large enough so as not to exceed the safe compressive strength of the insulation. It is more important to keep preserved wood foundations warm and the moisture content low than it is for masonry walls.

The interior of the basement wall will need to be finished if the basement is to be used as living space. Any wood members placed against a masonry wall must be protected from moisture up to grade level. It must be recognized that if interior insulation is used the wall will become very cold in winter, especially above-grade. If the vapour barrier and air retarder is not well sealed, moisture will condense on the cold masonry surface and either run down the inside of the wall or diffuse through the concrete. If the concrete is in a constant state of high moisture, freeze-thaw deterioration may become a problem. In summer, the bottom of the wall will be at about 10°C and warm humid basement air entering the insulated cavity could yield condensation in significant amounts.

Insulation of basement floors is desirable for comfort and reduction of moisture content of the slab. Concrete floors usually are insulated under the slab and protection against rise of dampness is advisable. The air barrier should be continuous to reduce migration of radon gas into the living area. Special attention needs to be paid to the airtightness of the wall-slab detail to avoid air leakage into insulated spaces.

Slabs-on-grade and crawlspaces need special details to avoid potential adfreezing. With less heat available because of insulated assemblies, the soil can freeze to the foundation wall, possibly on both sides, and if ice lensing is possible vertical movement can take place. If the soil under the slab is frost-susceptible and frost is able to penetrate local areas of the slab near the foundation wall may be lifted. The solution is to replace the soil on both sides of the foundation wall and under the slab with non-frost-susceptible and free draining material.

Footings above frostlines can be used if insulation is designed such that unfrozen soil conditions are maintained at footing level.

4.3 ABOVE GRADE WALLS AND HEADERS

The function of a wall is the separation of living space from outdoor climate and the assembly includes interior finish, vapour retarder, air barrier, building structure, insulation, rain and wind penetration protection and exterior cladding.

4.3 ABOVE GRADE WALLS AND HEADERS (cont'd)

To accommodate large amounts of insulation and to facilitate a continuous air barrier, the framing regime can become complex with only some wood framing performing a structural function. It should be kept in mind that members of different lengths will exhibit different amounts of shrinkage on drying, as will materials with different coefficients of moisture expansion. It is possible that forces for deformation will be generated which traditionally have not been a problem.

The major problems of walls are thermal bridging of studs and framing around windows, and airsealing of windows and headers. Double stud framing and standoff systems are used to reduce thermal bridging and to improve the continuity of the insulation. Since natural and forced convection can occur within insulated cavities, compartmentalizing insulation to ensure its full insulation value is good practice.

One method of ensuring an airtight header is by the use of modified balloon framing. In this detail the floor system, which includes a header band, is attached to the inside surface of the studs. It is desirable to position the header on the warm side of the dew-point, i.e. two-thirds of the insulation is on the outside of the header so that the moisture content of the header is kept low. Firestops must be provided at each floor level.

The exterior of the insulation should be covered with a vapour-permeable air barrier. For wind-driven rain protection an airspace (about 25 mm) should exist between the outside of the insulated assembly and the exterior cladding. Proper flashing at the bottom of the cavity should be provided. If rigid vapour-retarding sheathing is used as exterior insulation, it is possible for condensation to form at this surface. Again providing proper flashing details is good practice.

4.4 ROOF SPACES

The ceiling area is likely to be penetrated by plumbing stacks, light fixtures and exhaust fans/ductwork. Special attention must be paid to these details with respect to airsealing and vapour transmission, since warm humid exfiltrating air and moisture entering the attic space can cause significant problems. With higher insulation levels the attic air and surface temperatures are colder and formation of ice build up is likely if there is a continuous supply of moisture to the attic.

As some moisture can always be expected to enter the attic space, ventilation is required. Care needs to be taken that the soffit vents are not blocked by insulation. This is usually ensured by installing baffles to create ventilation channels free of obstructions. At the same time, in windy conditions, cold air entering at high speed should be prevented from blowing through the attic insulation by the installation of vertical baffles. Ridge vents can be used in combination with soffit vents to obtain more effective ventilation.

4.4 ROOF SPACES (cont'd)

It is important to maintain significant insulation values at the eaves. The "1983 Measure for Energy Conservation" specify that RSI 2.1 be maintained above the inner surface of the exterior wall. Raised heel trusses have become relatively common for accommodating higher insulation levels at eave locations.

5.0 PRACTICAL APPLICATION

Each of the details included in the report had been successfully used and was intended to be reused by the respondent. Therefore, from the perspective of at least one builder, each detail had good practical application. However, one finding of the study was the confirmation that builders lack the resources to track material and labour costs for individual assemblies. Their selection of building systems and details was therefore not based on a strict assessment of past results but was a much more subjective process.

Assuming that the system meets the necessary technical performance standards an objective practical assessment of a system should include at least the following criteria:

Material and Labour Cost
Trade Acceptance
Forgivability
Flexibility

5.1 MATERIALS AND LABOUR COST

Material costs fluctuate with market demand and vary by region. Building systems which use standard mass produced items containing inexpensive raw materials, such as fiberglass batts and precut 38 x 89 wall studs, tend to have lower material costs than systems which require non-standard lumber and rigid or semi-rigid insulation. However the overall cost of the latter will be lower if labour cost reductions exceed incremental materials costs. Materials costs are simple to estimate for individual buildings but labour estimates must take into account set-up time and interfacing requirements with other subtrades and building systems. Additional supervision time should also be included.

5.2 TRADE ACCEPTANCE

The success of a building system will largely be determined by the enthusiasm with which it is adopted by the trades. If a particular method or material, such as acoustical caulking, is strongly disliked by those responsible for its application, performance will depend upon enforcement by supervisors. Regardless of how cost effective the system may be on paper in practise the builder will have constant difficulties. This was found to be the case in the Pacific north west where trades' aversion to caulked polyethylene air-vapour barriers resulted in several builders switching to a wall system with an interior rigid foam board air-vapour barrier.

5.3 FORGIVABILITY

A system which demands close dimensional tolerances and unrelenting accuracy on the part of the trades will not be suitable for widespread adoption. Housing is constructed in all weather conditions and systems in which weather sensitive materials are left exposed for periods of time will also be limited in applicability. This applies, for example, to floor and wall systems where polyethylene film or fiberglass batt insulation is exposed to weather. Some techniques can be dangerous in poor weather conditionss for example polyethylene draped over top plates is extremely slippery when wet. Systems should be assessed for worker safety to reduce risk of accident.

5.4 FLEXIBILITY

The ability of a building system to adapt to a variety of architectural styles is important. For example it is difficult to attach brick veneer to wall systems in which the outer framing is non-loadbearing and overhangs the foundation. It will also be desirable for a wall system to be compatible with more than one foundation system so that special site circumstances may be accommodated. Flexibility in materials use is also advantageous so that substitutions can be made should market changes occur in product costs or availability.

6.0 SUMMARY FINDINGS AND RECOMMENDATIONS

6.1 DISTRIBUTION OF BUILDING SYSTEMS

The questionnaire results demonstrate that a variety of building systems are currently being used across the country; fifteen different wall types have been documented in this report and grouped into five major categories. The expected regional bias towards certain system types was not substantiated and examples of most of the systems were found in each region. The three most frequently occurring wall systems were single stud with insulating sheathing, double frame, interior wall loadbearing and single stud, wrap and strap. The majority of reported foundations were concrete with exterior insulation. Almost all the houses were built with raised heel roof trusses.

An interesting point to note is that several hundred double frame, interior wall loadbearing units were built by a public agency under standard funding arrangements.

6.2 TECHNICAL PERFORMANCE

In general, the evaluated details showed better performance characteristics in all criteria than conventional construction. One of the problems the consultants faced in evaluating the details was the lack of available test data. The submitted drawings provided many examples of assemblies which are apparently performing successfully in the field but which have not undergone laboratory testing to determine their structural, thermal or air sealing limitations. Such testing would identify details which require improvement and would permit the refinement of assemblies which contain redundancies.

6.3 MATERIALS AND THE ROLE OF THE MANUFACTURER

Although the builders demonstrated some ingenuity in adapting materials to meet their needs, they must rely to a large extent on the manufacturers and suppliers to provide suitable products. In some instances the manufacturers have responded quickly to the builders' changing requirements, for example insulation batts were specified in several thicknesses which until very recently were unavailable. The widespread use of permeable plastic sheathing paper also indicates an ability on the part of suppliers to rapidly get a new product into the national marketplace. Other industries have for various reasons, been unable to respond to the needs of the energy efficient builder. Windows and doors for example are not designed for airtight housing. A manufacturer-installed perimeter gasket would eliminate the plastic 'window wrap', other improvements might include interior or exterior mounting flanges and jamb extensions; these items would make detailing and site installation considerably easier, and their use would not necessarily be limited to energy efficient housing. The electrical industry has also failed as yet to provide a solution to the problem of locating wiring in exterior assemblies. An airtight outlet box would be well received and adaptations of existing commercial products for surface mounting could be directed at the residential market.

6.4 TECHNICAL TRANSFER

Some respondents included photocopies of details from published sources, others appeared to be using such resources to prepare their drawings. It was clear that many builders were not in a position to provide in drawing form the detailed and fully-specified information required to build energy efficient housing and much information was therefore transferred verbally on the building site.

6.5 RECOMMENDATIONS

Research and Testing

1. Structural limitations of some assemblies should be determined. These include:

   - Floor/wall junctions of balloon frame systems
   - Strength of expanded or truss wall studs
   - Standoff trusses
   - Window support in thick wall systems
   - Use of drywall to provide racking strength

2. Loss of insulation value in certain assemblies should be investigated, including:

   - Effects of convection loops in thick wall assemblies
   - Effects of thermal bridging through metal fasteners, with and without metal siding
   - Fin effect of thermal bridging through exterior insulated masonry foundations to brick veneer
   - Fin effect of thermal bridging where drywall contacts studding
   - Thermal bridging at garage/house foundation junction
   - Thermal bridging at masonry penetration of envelope

3. Impact of fire in fully insulated wall cavities should be investigated:

   - Fire stop requirements between floors

4. Longevity and performance of air sealing materials should be determined:

   - Polyethylene and Tyvek™
   - Caulking and sealants
   - Tapes
   - Foamed in place materials
   - Foam ropes and gaskets
   - Loading effects on air barrier membrane - wind, thermal, shrinkage

5. Impact of separation of air barrier and vapour retarder functions on moisture transport.

Technical Transfer

6. A builder's guide is needed for the preparation of working drawings and specifications for single family energy efficient homes. The contents of tender documents differs from conventional housing and information adequate for permit purposes is inadequate for correct construction. The guide should function in part as a master specification.

7. The establishment of a centralized library of details is a highly desirable goal which will be to the long term benefit of the Canadian housing industry and the homeowner. Other studies, notably 'Construction R D & D in Canada' by Revay, 1983 have found inadequate levels of research and development in the Canadian construction industry. The results of the details project

6.5 RECOMMENDATIONS (cont'd)

indicate that builders are applying inadequate resources to the development of new construction techniques in the housing industry to the point where working drawings often ignore or omit basic rules of sound construction practice. Access to a library of annotated details describing sound and current construction practice would result in an immediate and radical improvement in the level of information provided to the trades by the builder and small design firm.

8. A library suitable for the Canadian home building industry might logically be administered by the industry association, CHBA, with technical review functions provided by the various research and regulatory bodies. Operation costs of the system could reasonably be expected to be borne by the users however adequate monies would have to be allocated from research funds or other public sources to cover set up costs and future system expansion.

   A task force of interested parties should be established to provide an in depth feasibility report including administrative and funding requirements and if appropriate, terms of reference for system or service supply tenders.

9. As part of the function of the details library, a mechanism for the ongoing identification of new methods and details is needed. This might be accomplished simply by requesting documentation from originators who would be rewarded with an acknowledgement. Such methods are usually non proprietary.

10. Manufacturers and manufacturers' associations should be encouraged to develop improved products for the energy efficient housing market.

    - Polyethylene air-vapour barriers
    - Gaskets and caulks
    - Window and door mounting flanges and gaskets
    - Electrical wiring and boxes
    - Expanded studs

SECTION 2

THE CODING

Each drawing has been given a code which describes the construction type and the location or interface of the detail.

CONSTRUCTION TYPE. Above grade walls (A.G.W.) were allocated as follows:

Single frame systems

Exterior insulating sheathing with modified platform frame	AGW 11
Two layers of exterior insulating sheathing	AGW 12
Exterior insulating sheating with drywall air barrier	AGW 13
Impermeable insulating sheathing on inside of frame	AGW 14
Wrap and strap system using 64 mm strapping	AGW 21
Wrap and strap system using 38 mm strapping	AGW 22
Interior 64 mm strapping, conventional sheathing	AGW 23

Thick wall systems

Double frame, interior wall loadbearing	AGW 51
Double frame variation, interior wall loadbearing	AGW 52
Double frame, exterior wall loadbearing	AGW 53
Double frame variation, exterior wall loadbearing	AGW 54
Standoff system using manufactured truss	AGW 61
Standoff system, site built	AGW 62
Standoff system using metal channel	AGW 63
Expanded stud system, truss with plywood gusset plates	AGW 71
Expanded stud system, truss with metal webs	AGW 72

Below grade walls (B.G.W.) were allocated:

Concrete, exterior insulation	BGW 21
Concrete, interior insulation	BGW 22
Concrete, exterior and interior insulation	BGW 23
Insulated blocks 'sparfil'	BGW 24
P.W.F. expanded stud	BGW 25
P.W.F. double wall	BGW 26
P.W.F. on concrete footings	BGW 27
P.W.F. grade beam	BGW 28
P.W.F. on crushed stone	BGW 29
Uninsulated	BGW 20

Roofs (RF) were allocated:

W truss, raised heel	RF 31
W truss, dropped bottom cord	RF 32
Scissors truss	RF 33
Parallel cord truss, metal	RF 34
Parallel cord truss, site built	RF 35
Rafter	RF 37
Rafter with purlins	RF 38

THE CODING (cont'd)

INTERFACE. Detail drawings were described as follows:

JUNCTION	sill AGW/BGW		I 01
	BGW/Footing		I 03
	intermediate floors		I 06
	heated/unheated AGW		I 07
	cantilever		I 08
	Floor over unheated space		I 09
	eave AGW/RF		I 10
	gable AGW/RF		I 11
	clerestory AGW/RF		I 12
	shed roof/AGW intersection		I 13
	split level ceiling		I 14
	roof ridge		I 16
OPENING	AGW window		I 22
	AGW door, single		I 25
PENETRATION	Pipe or plumbing vent	BGW	I 31
	" " "	AGW	I 32
	" " "	RF	I 33
	" " "	non-specific	I 34
	Flue or chimney	RF	I 36
	Electrical outlets	AGW	47
	outlets	RF	48

GRAPHIC CONVENTIONS

The drawings have been standardized in some respects to facilitate comparisons.

Concrete foundations are shown as 200mm poured concrete.
Exception: insulated concrete block is shown as such.
Preserved wood foundations are shown as 184mm thick.
Exception: double frame preserved wood foundation.
Single stud walls are shown with 38 x 140mm studs, except where this thickness is inappropriate. Single stud wall plates are shown as 38 x 89 provided this thickness does not detract from the performance of the detail.
Double frame, standoff systems and expanded stud walls are generally shown as 300mm thick.
Loadbearing walls are drawn with 38 x 89mm studs and non loadbearing walls are drawn with 38 x 64mm studs.
Floor joists are shown as 38 x 235mm.
Insulating sheathing is 38mm thick, except where special thicknesses are called for.
Dimensions have been eliminated from the drawings since they vary with application.

ASSUMPTIONS FOR NOMINAL RSI CALCULATIONS

ABOVE GRADE WALLS

BATT MM	RSI	BOARD MM	RSI
38	.9	25	.7
64	1.4	38	1.1
89	2.1	50	1.4
140	3.5		
184	4.9		

BELOW SLAB BOARD

MM	RSI
38	1.3
50	1.8

ASSUMPTIONS FOR 'MODIFIED' RSI CALCULATIONS

Modified RSI values have been calculated for each major type of above grade wall assembly in an attempt to account for the effect of the framing members. However even when the heat transfer is restricted to conductive heat flow, the mechanism is complex and three-dimensional. Due to thermal bridging some areas will be colder than others (e.g. wood has a steeper temperature profile than the adjacent insulated areas) and heat will flow from warm to cold irrespective of direction. Some thermal bridges

ASSUMPTIONS FOR 'MODIFIED' RSI CALCULATIONS (cont'd)

can be very significant if highly conductive materials with large exterior areas are used. Connectors can short-circuit the insulative properties of a wall assembly, especially if used to attach metal siding. In this case a "fin effect" heat loss mechanism is created which, with cold air on both sides of the siding can reduce the effectiveness of the insulation value substantially due to the large area of metal per connector in contact with cold air. This effect is dependent on choice of materials, possibly made by the site contractor, and is mentioned here as a caution that the calculations below include assumptions that may produce inherently optimistic results.

The following assumptions have been made:

1. Heat flow through wall components is strictly perpendicular to the plane of the building assembly. This accounts for heat flow generally only in the direction of a thermal bridge (e.g. wood studs or plates).

2. Parallel and series heat flow principles have been used to derive a modified overall wall insulation value. Typically, average RSI-values for layers of insulation (e.g. exterior sheathing) or obvious partial building assemblies (e.g. insulated stud walls, header bands) were determined from which further parallel/series heat flow was used to determine the overall value. More detailed calculations are possible, but accuracy would be increased only very slightly over the above procedure.

3. The wall assemblies do not include windows and their framing which would significantly reduce the overall insulation value for a particular wall.

4. Basement wall RSI-values may be significantly less than the wood frame assembly above.

5. The following dimensions and configurations were used in calculations.

   - stud spacing: 38 x 89 framing at 400 mm o.c.
     38 x 140 framing at 600 mm o.c.
   - strapping: 38 x 64 horizontlal framing at 600 mm o.c.
   - standoff-truss at 600 mm o.c.
   - exterior sheathing - 38 mm thick

6. Buffered ambient air is able to penetrate behind all siding and the outdoor film coefficient used was 0.05 $m^2 \cdot {}^oC/W$. The indoor film coefficient was the standard still air value of 0.12 $m^2 \cdot {}^oC/W$.

The following definitions are used for comparing RSI values.

Nominal - Maximum insulation material provided at a particular location (excludes "non-insulative" sheathing, airfilms, etc.).

ASSUMPTIONS FOR 'MODIFIED' RSI CALCULATIONS (cont'd)

Modified - RSI-value derived from parallel/series heat flow calculations accounting for all framing, sheathing and airfilms.

Thermal Effectiveness - ratio of Modified to Actual "Nominal" RSI-value

Comparison of Nominal and Modified RSI-values indicates that the Nominal value is a good estimate for the overall RSI-value especially if a reduction for additional thermal bridging is considered.

DRAWING	NOMINAL INSUL. ONLY	ACTUAL "NOMINAL"	MODIFIED RSI	THERMAL EFFICIENCY
AGW 11 1	4.6	4.85	4.28	0.88
AGW 12 11	6.5	6.86	6.46	0.94
AGW 13 15	4.	4.68	4.08	.87
AGW 21 24	5.9	6.24	5.5	.88
AGW 22 32	4.4	5.07	4.66	.92
AGW 51 46	7.0	7.36	6.44	0.875
AGW 53 56	7.0	7.32	6.7	0.915
AGW 61 66	7.0	7.36	6.53	0.89
AGW 71 76	7.0	7.5	7.22	0.96

It can be seen from the table that there is a small reduction from the "nominal" RSI value to the "modified" value. Other effects such as heat flow through connectors, air movement and gaps in the insulation caused by imperfect installation are likely to be of greater significance.

SUMMARY OF DRAWINGS

The following table gives the number of drawings by above grade wall type and location, included in this report.

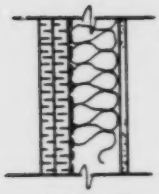
		Building Section	Plan	Footing, I 03	Sill, I 01	Intermediate Floors	Window, I 22	Door, I 23	Eave, I 10	Gable I 11
Single Frame										
Insulating sheathing	AGW 11	1	1	2	3	1	1		1	
Double thickness	AGW 12	1	1	1	1				1	
Drywall	AGW 13	1	1	1	1	1			1	
Interior sheathing	AGW 14		1		1		1			
Wrap & strap, 64 mm	AGW 21	1	1	2	2	2			1	
Wrap & strap, 38 mm	AGW 22	1	1	1	2	2	1		2	1
Strap only	AGW 23				3	1				
Thick Wall										
D.F. interior loadbearing	AGW 51	1	1	1	1	1	1	1	1	1
	AGW 52		1						1	
D.F. exterior loadbearing	AGW 53	1	1		3		1			
	AGW 54		1		1	1			1	
Standoff, manufactured	AGW 61	1	1	3	2	1	1		1	
Standoff site built	AGW 62		1		1					
	AGW 63				1					
Expanded stud system	AGW 71	1	1		1	1			1	
	AGW 72		1	1	1				1	

Non Specific	
Roofs	3
Pipe & vent penetrations	3
Chimney	1
Electrical outlets	4
Window wrap	1

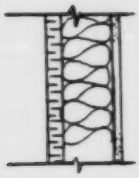
Note that some drawings are applicable to more than one wall type; the number of drawings here is therefore greater than the number of details.

SINGLE FRAME SYSTEM WITH INSULATED SHEATHING

AGW 11



AGW 12



AGW 13

AGW 14

The simplest type of upgrade to wall construction involves substituting an insulated sheathing board for conventional sheathing materials and providing improved airtightness.

Depending on the thickness of the studs 89 or 140 mm, and the thickness and type of sheathing board used, nominal R values range from about R 6 to R 3. Actual R values may be assumed to be about 10% less than nominal.

The following section documents four variations of this system:

AGW 11 drawings show a polyethylene air-vapour barrier installed directly behind the drywall and a modified platform frame system.

AGW 12 drawings show the polyethylene air-vapour barrier mounted on the exterior of a conventional frame with two layers of thick foam board applied over it.

AGW 13 drawings show a modified balloon frame with the drywall used as the air barrier.

AGW 14 drawings show impermeable insulated sheathing installed on the inside of the frame acting as the air-vapour barrier. The latter system does not include a full building section.

Observations:

1. Insulated sheathing does not function as bracing and an alternative such as let in diagonal bracing must be used to stiffen the frame.

2. Air leakage must be minimized to reduce risk of moisture damage. (This is equally true of conventional construction.) Trades training and site supervision will be required to explain and obtain good air sealing techniques.

BUILDING SYSTEM USING SINGLE STUD FRAMING WITH EXTERIOR INSULATING SHEATHING ON CONCRETE FOUNDATION

The building section shown illustrates a frequently used combination of systems:

Concrete foundation with exterior insulation
Single frame wall with exterior insulating sheathing
Raised heel standard truss

The section closely reflects standard platform frame construction practices with several minor variations intended to improve the thermal performance of the envelope. The system allows for nominal insulation levels up to about RSI 5 and, as detailed, allows for the installation of a continuous air vapour barrier. Recessing of floor headers allows for higher levels of insulation at this assembly.

Nominal RSI: 4.6 Modified RSI: 4.28

System advantages:

- requires only minor modifications to framing practices including:
  - let-in diagonal bracing must be installed
  - polyethylene strip must be installed between wall top plates
  - 38 x 89 wall top and bottom plates replace 38 x 140 plates in most locations

System Disadvantages:

- difficulty in sealing electric and plumbing penetrations
- relatively low insulation levels at foundation wall
- susceptibility of air barrier to damage both during and after construction (i.e. drywallers, hanging pictures, etc.)

All AGW 11 drawings describe this wall type.

DRAWING #

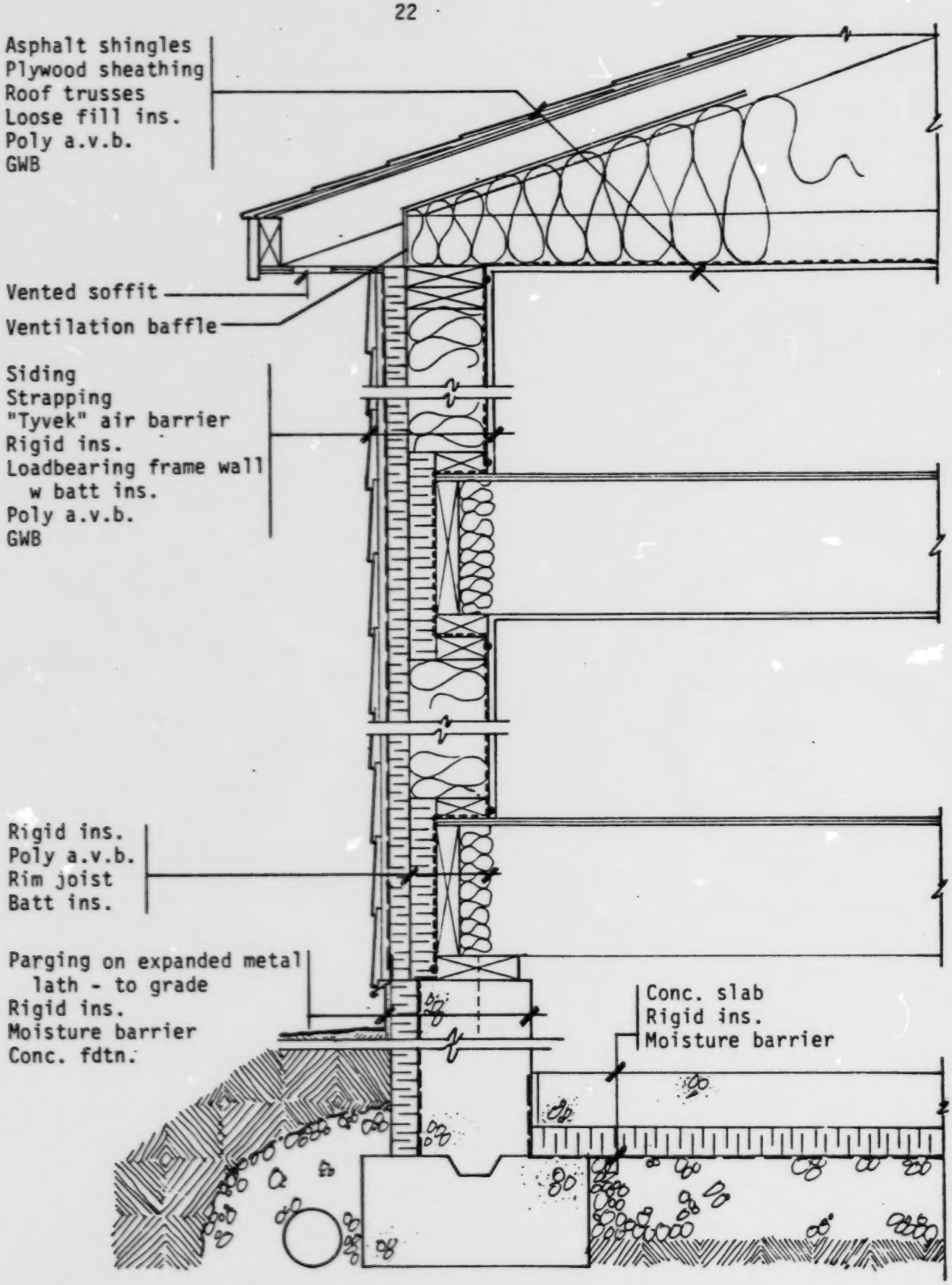
			2	PLAN OF WALL
	4	3		FOOTING
	7	6	5	SILL
			8	INTERMEDIATE FLOOR
		9		WINDOW
		10		EAVE

KEY DETAILS

Refer also to the sections on roofs, openings and penetrations for other applicable details

AGW	BGW	RF	I		DATE	SCALE	DRWG #
11	21	31			12/84	1:10	1

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
11	21	31			12/84	1:10	1

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

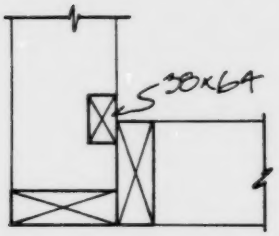
PLAN VIEW OF SINGLE STUD WALL WITH INSULATING SHEATHING

This plan view of the single stud with insulating sheathing system demonstrates corner detailing employing three studs and the installation of an air barrier over the insulating sheathing.

Technical Performance:

- as drawn (without electric or plumbing penetrations) an effective air barrier can be installed
- the use of a secondary exterior air barrier (Tyvek) reduces convective air movement in the batt insulation
- the optional use of cross strapping before siding provides improved moisture protection for the wall (rain screen principle)

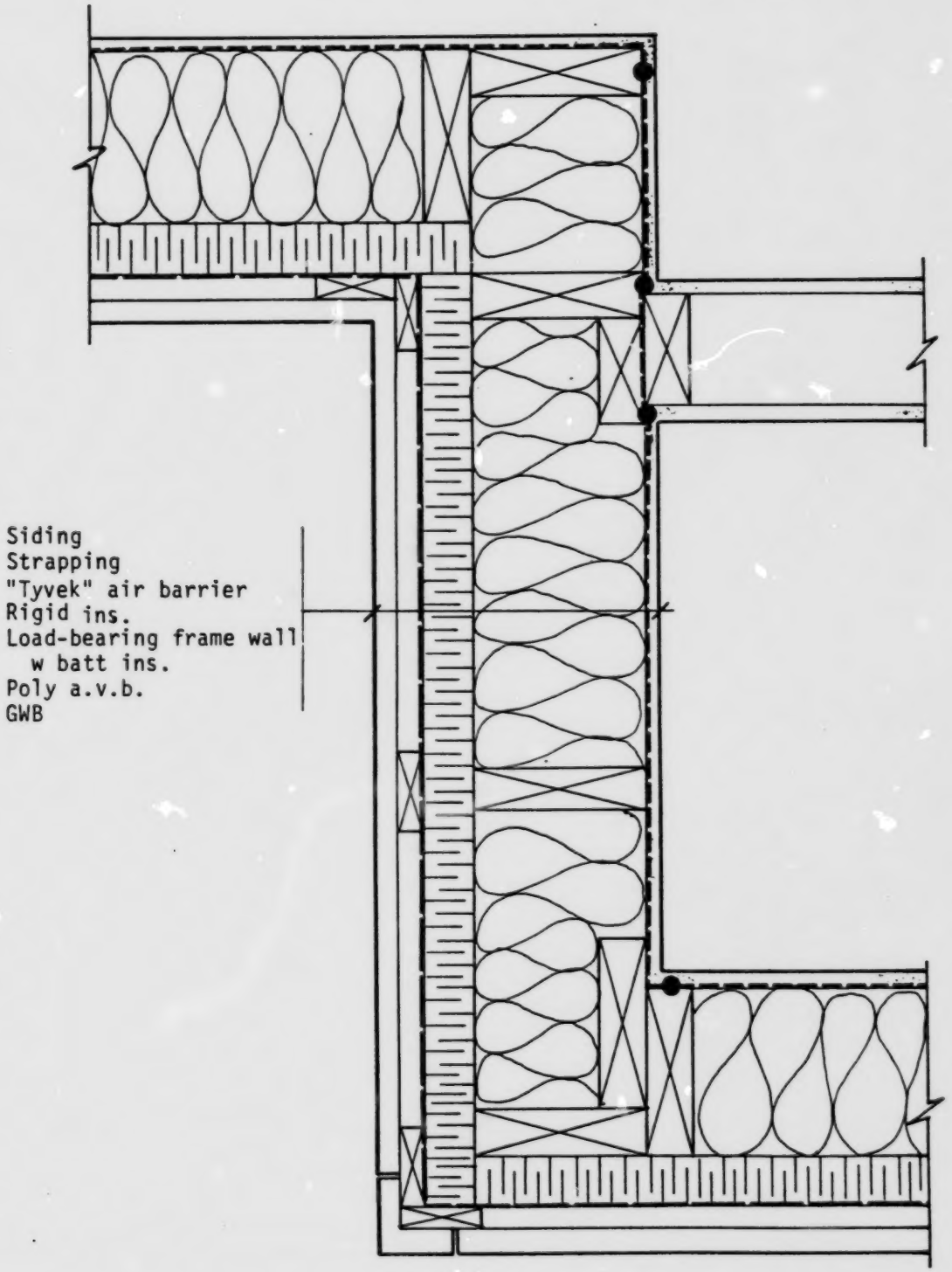
Practical Application:



- two-stud corners and the use of drywall corner clips can reduce material costs (and minimize thermal bridging)
- alternatively inside corners can be assembled as drawn
- supervision of drywallers may be required to reduce the risk of mechanical damage to the air barrier
- air sealing of any penetrations through the polyethylene will require additional labour

AGW	BGW	RF	I		DATE	SCALE	DRWG#
11	--	--	07		12/84	1:5	2

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
11	--	--	07		12/84	1:5	2

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

CONCRETE FOUNDATION WITH EXTERIOR RIGID BOARD INSULATION

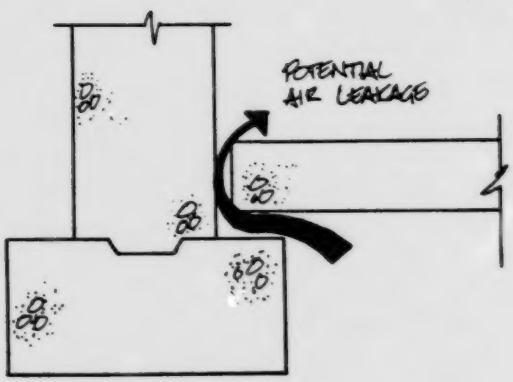
This detail is typical of the submitted drawings, except for the use of the cove at the base of the wall which provides increased moisture protection.

Technical Performance:

- exterior insulation provides freeze protection to the foundation wall
- basements in dry soil conditions do not benefit significantly from underslab insulation
- the underslab moisture barrier should also function as an air barrier to prevent air leakage at the slab edges

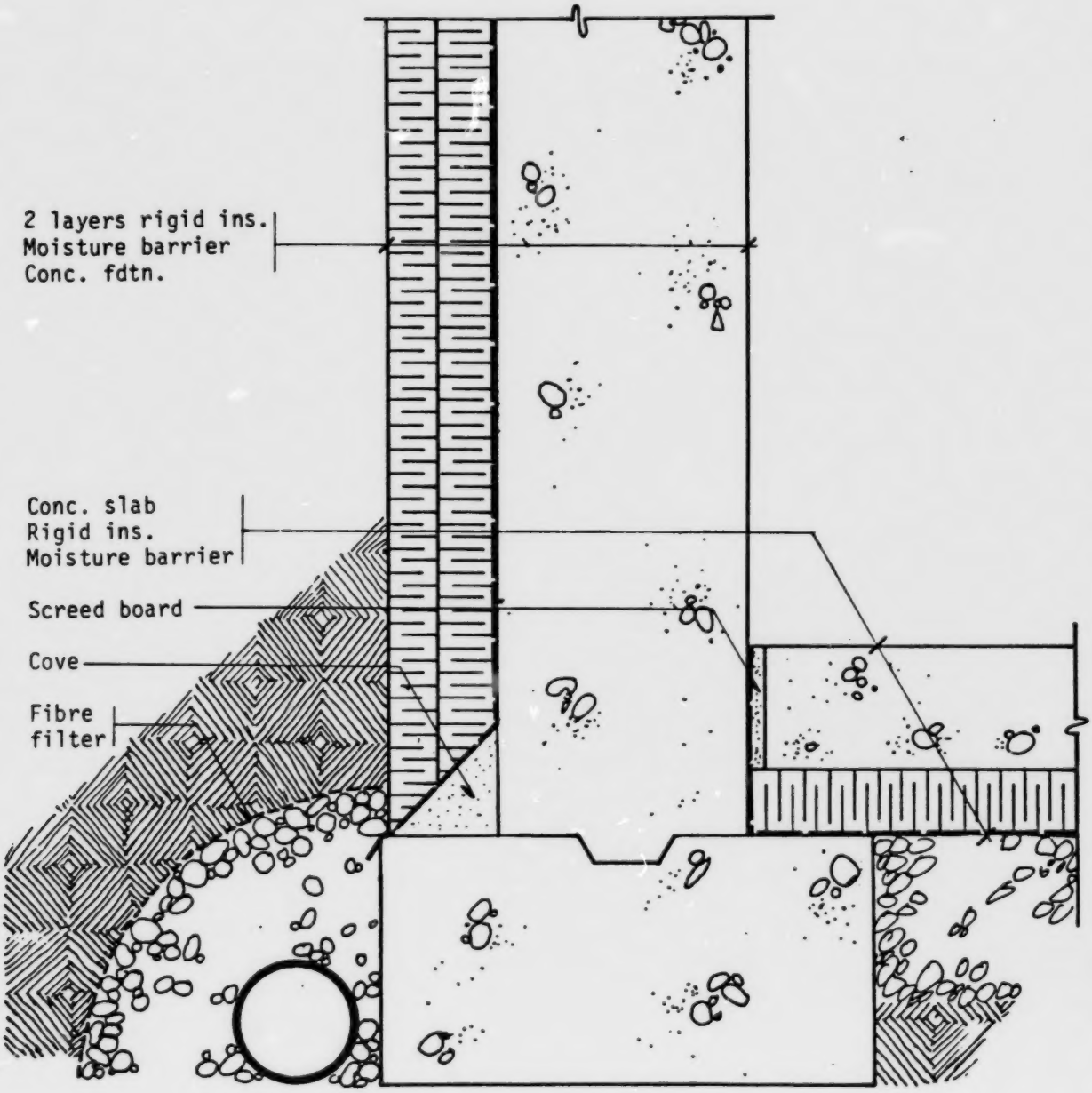
Practical Application:

- exterior insulation materials include extruded polystyrene, Type IV, expanded polystyrene, Type II and approved semi rigid fibreglass. The latter material also provides some drainage and may be preferable in termite areas
- normal good practise for dampproofing, perimeter drainage and backfill procedures must be followed



AGW	BGW	RF	I		DATE	SCALE	DRWG#
--	21	--	03		12/84	1:5	3

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

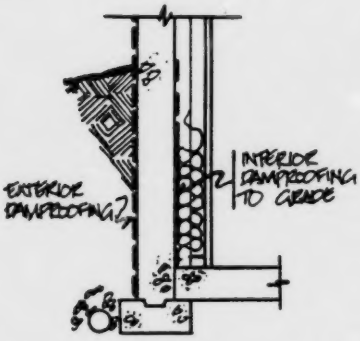


AGW	BGW	RF	I		DATE	SCALE	DRWG#
--	21	--	03		12/84	1:5	3

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

POURED CONCRETE FOUNDATION WITH INTERIOR INSULATION

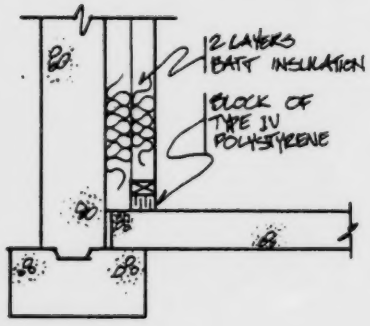
Technical Performance:



- in poorly draining soils this system increases the possibility of frost adhesion and frost heaving
- as drawn, the detail lacks dampproofing on the interior side of the foundation wall. Polyethylene should cover the wall to grade level
- a layer of Type IV extruded polystyrene should be located under the wall bottom plate. This technique keeps the bottom plate dry

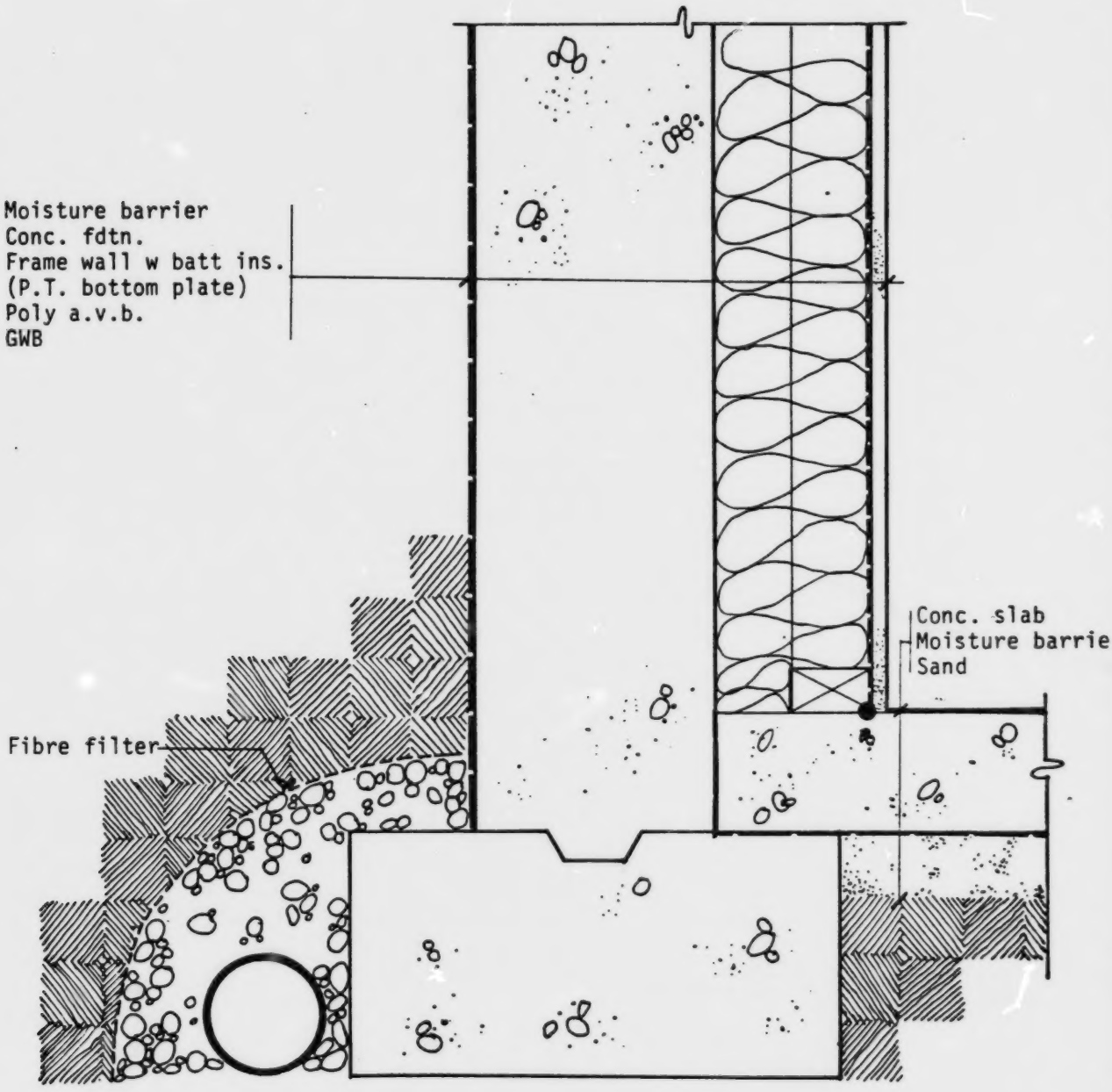
Practical Application:

- for best performance batt insulation should be installed in 2 steps; first horizontally between studs and wall (RSI 1.4) and then vertically in stud cavities (RSI 2.1). As drawn a gap is left behind each stud which reduces the effectiveness of the insulation



AGW	BGW	RF	I		DATE	SCALE	DRWG#
--	22	--	03		12/84	1:5	4

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
--	22	--	03		12/84	1:5	4

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

SILL DETAIL, SINGLE FRAME VARIATION WITH EXTERIOR FOUNDATION INSULATION

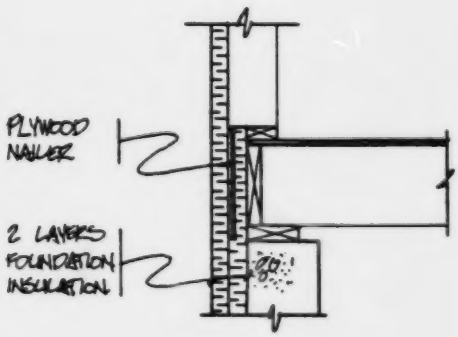
Header location is partially inset with respect to frame wall but use of 38 x 89 bottom plate reduces associated labour requirements. Detail allows for good airtightness and reasonable insulation levels without demanding major alterations in construction practices. The recessed bottom plate and sill eliminates thermal bridging. The vertical strapping is required to support the siding at the header area and also provides a desirable air space between siding and sheathing.

Technical Performance:

- batt insulation could be fitted between floor joists provided about 2/3 of the total R value of the assembly remains on the outside of the vapour retarder
- foundation wall dampproofing can double as the air barrier if joined to polyethylene above
- foundation insulation levels are low in relation to above grade walls

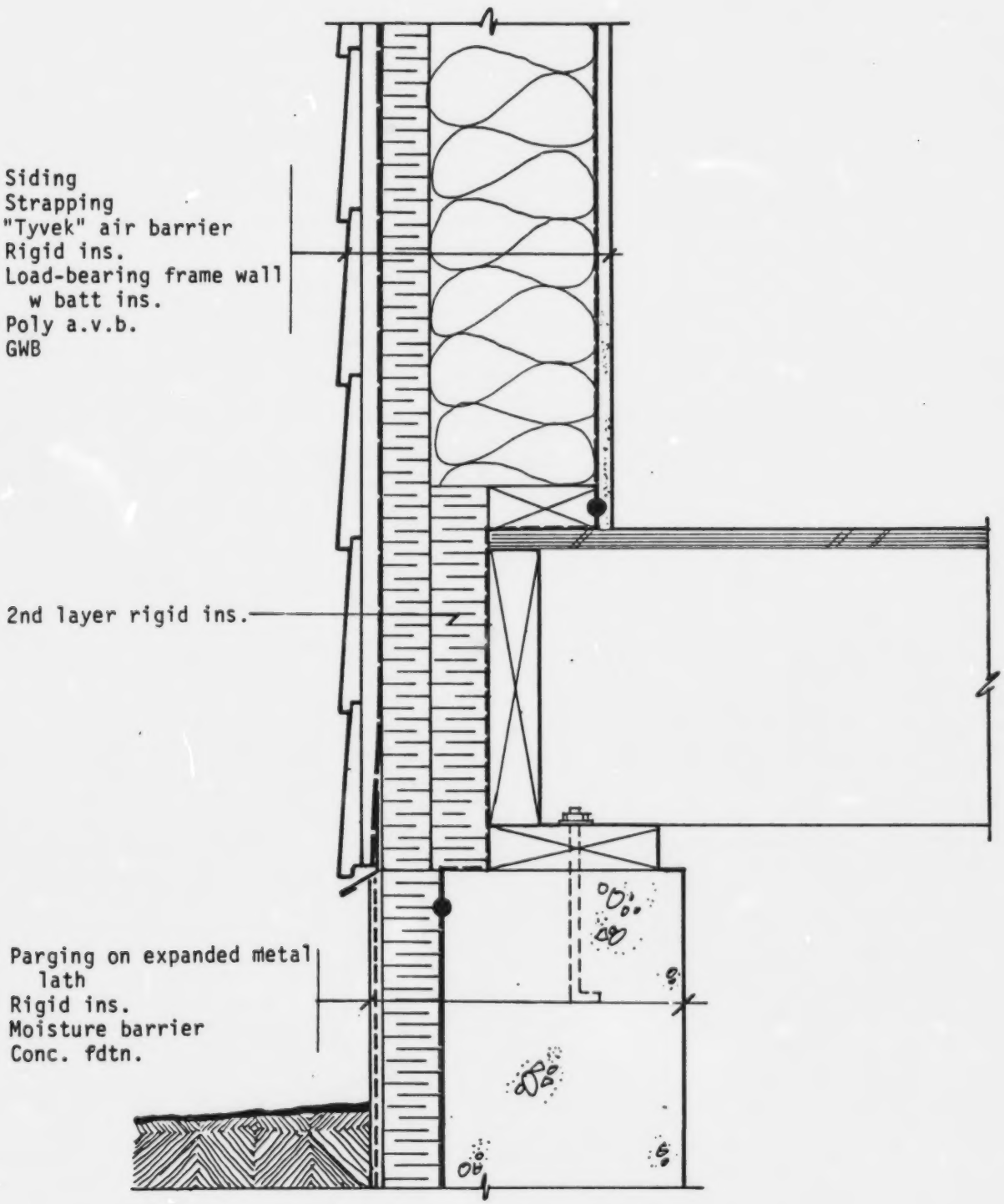
Practical Application:

- plywood nailer may be required to ease installation of siding at joist header. Use of a plywood nailer eliminates need for strapping
- foundation wall could be inset to allow easier purchasing and installation of exterior insulation as drawm
- top of expanded metal lath should overlap sill plate to allow for easy nailing - otherwise a nailer can be cast in place
- galvanized concrete nails can be difficult to find in longer lengths - (i.e. when using 100 mm of insulation)
- flashing detail behind siding must prevent water from continuously dripping on parging
- use of 38 x 89 wall bottom plate allows easy alignment of wall over floor header



AGW	BGW	RF	I		DATE	SCALE	DRWG#
11	21	--	01		12/84	1:5	5

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
11	21	--	01		12/84	1:5	5

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

SILL DETAIL SINGLE STUD SYSTEM WITH INTERIOR BASEMENT INSULATION

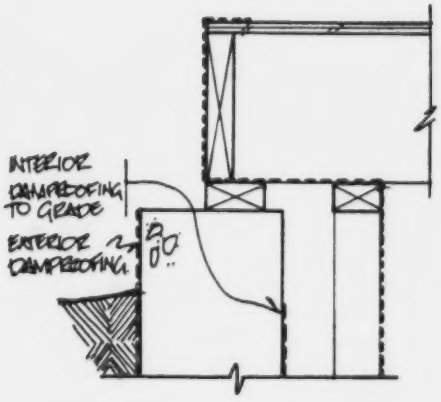
Floor joist header and sill plate are partially inset on foundation wall to allow for additional exterior insulation. Continuity of polyethylene air barrier from main floor to basement wall can allow good airtightness. The drawing does not show proper moisture and dampproofing details.

Technical Performance:

- dampproofing on exterior of foundation wall and dampproofing on interior to grade will be required
- the addition of batt insulation to the interior of the header raises concern for potential condensation at the sill plate

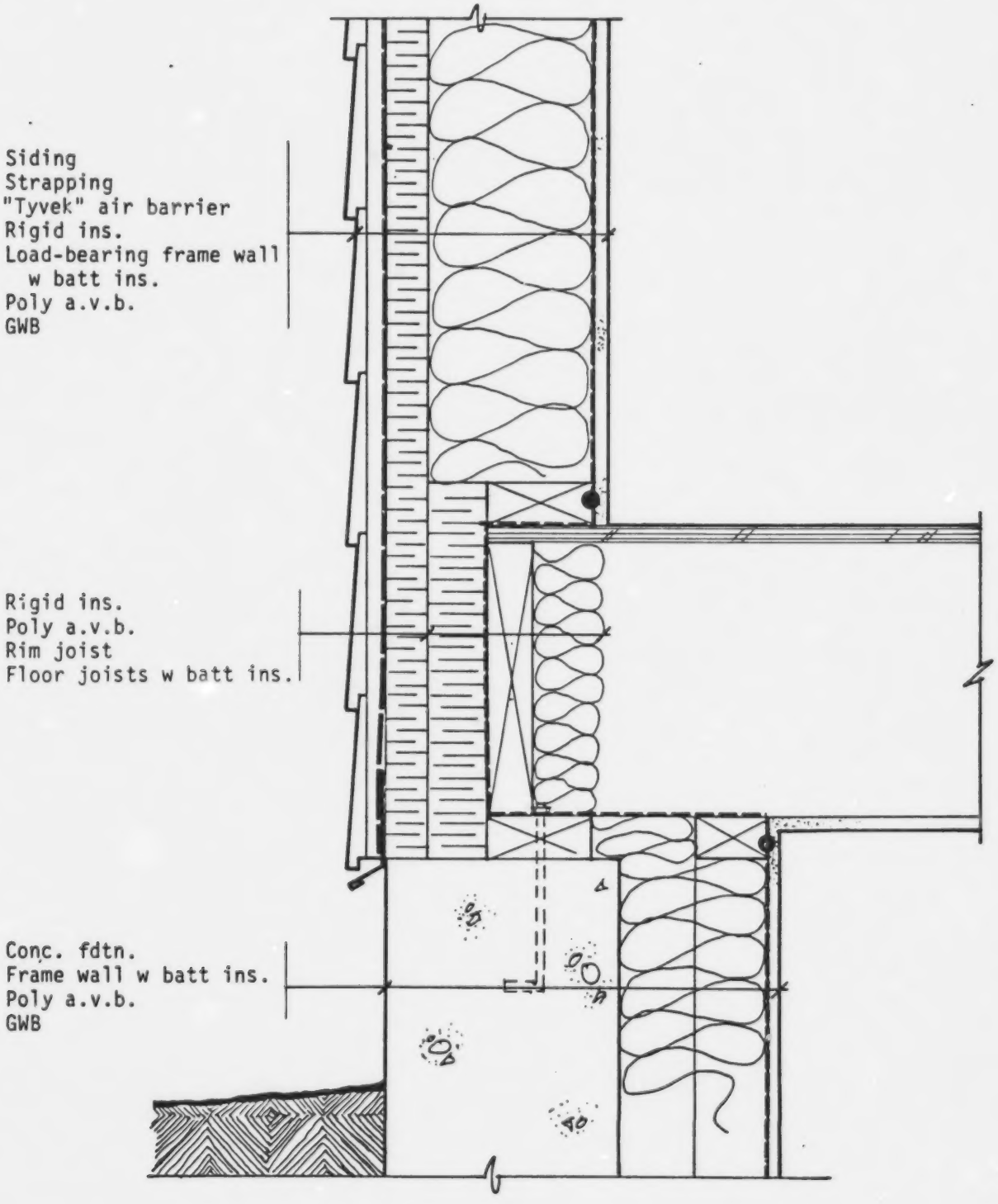
Practical Application:

- polyethylene can be easily damaged during placement of floor joists
- a plywood nailer between two layers or rigid insulation at the floor header could substitute for the exterior strapping
- the use of 38 x 89 bottom plates allows for easy alignment of the wall over the floor joist header



AGW	BGW	RF	I		DATE	SCALE	DRWG#
11	22	--	01		12/84	1:5	6

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



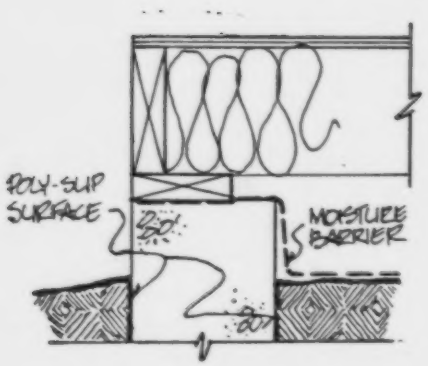
AGW	BGW	RF	I		DATE	SCALE	DRWG#
11	22	--	01		12/84	1:5	6

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

INSULATED WOOD FLOOR OVER UNHEATED CRAWLSPACE WITH SINGLE STUD WALL VARIATION

This system involves the use of sealed plywood as the air barrier over the floor of an unheated crawlspace.

Technical Performance:



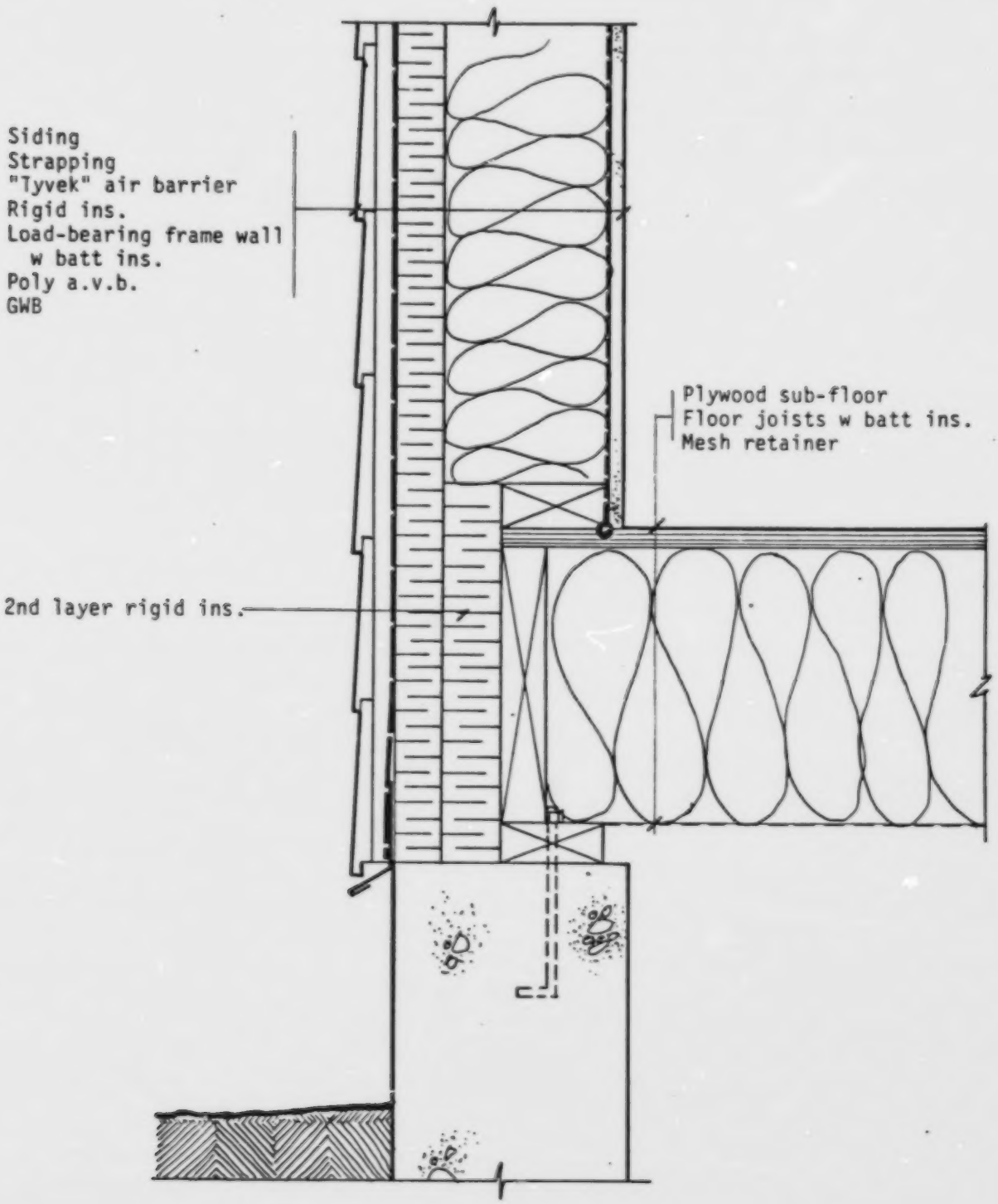
- proper foundation drainage and positive draining fill must be used to reduce the likelihood of frost heaving or adfreezing of soil to foundation wall
- the use of Tyvek as an air barrier on the underside of the floor joists can further reduce air infiltration, and will restrict air movement through the insulation
- the amount of insulation at the floor header is less significant over unheated crawlspace
- enting of crawlspace will be required during warmer months
- moisture barrier over crawlspace floor is required

Practical Application:

- ease of insulation installation will depend on accessibility to crawlspace - can be performed from above provided insulation can be kept dry during construction
- polyethylene could be extended below sub-floor and joined to air barrier at wall plate
- plywood subfloor must be sealed with caulk or adhesive

AGW	BGW	RF	I		DATE	SCALE	DRWG #
11	20	--	03		12/84	1:5	7

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
11	20	--	03		12/84	1:5	7

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

SINGLE STUD WALL WITH EXTERIOR INSULATION
INTERMEDIATE FLOOR FUNCTION WITH PARTIALLY INSET HEADER

This intermediate floor junction provides additional insulation at the floor header assembly and provides for protection of the polyethylene during installation of the floor joists.

Technical Performance:

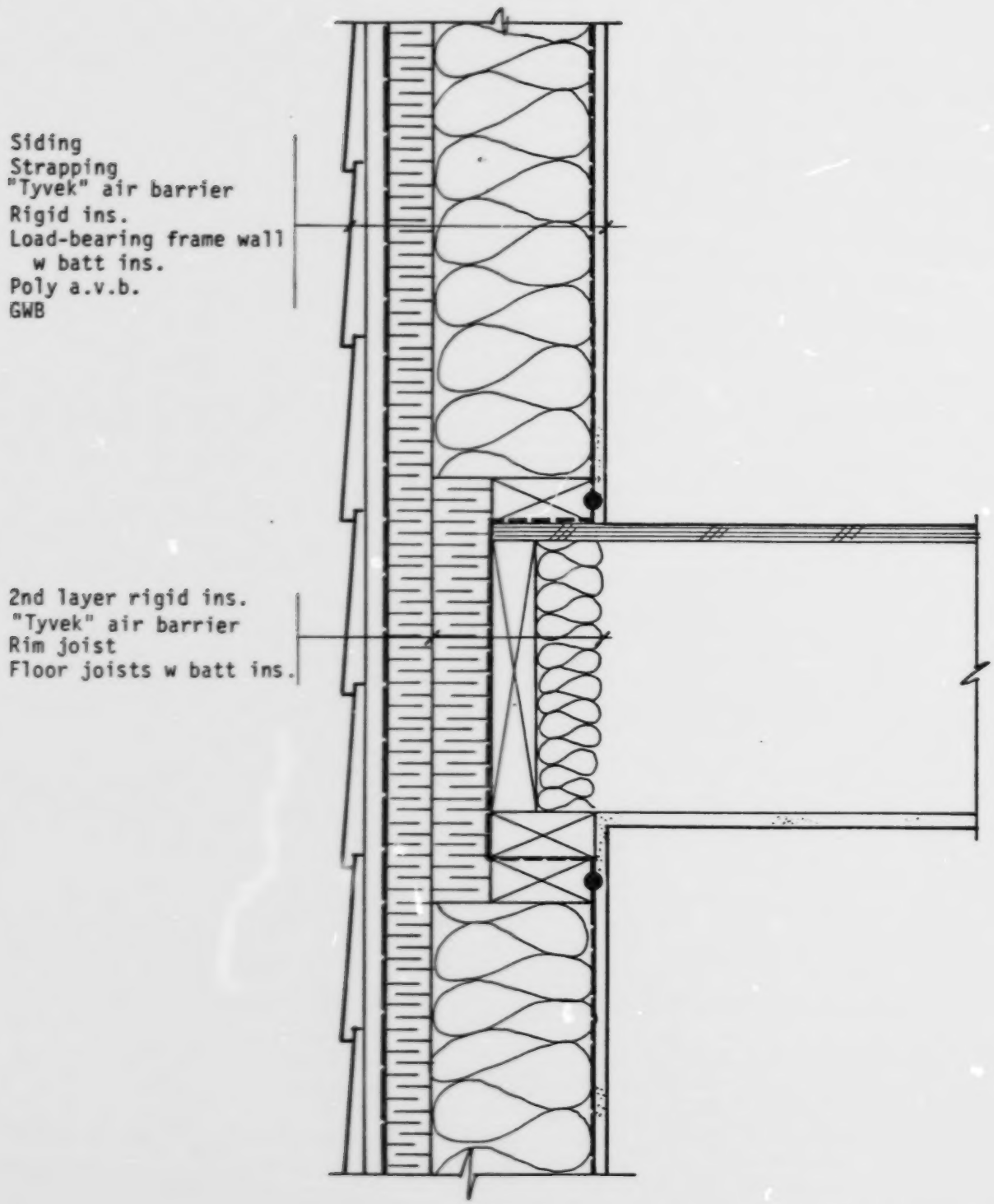
- a fully dimensioned top plate for the wall may be needed as a firestop between floors
- use of Tyvek™ over exterior insulating sheathing should result in effective air barrier
- Tyvek™ is used as junction strip between floors. Additional interior insulation should be protected with a vapour retarder

Practical Application:

- Tyvek™ must be sandwiched between wall top plates
- Tyvek™ may be damaged when 2nd storey wall is lifted in place
- use of 38 x 89 bottom plate allows easy alignment of wall over joist header

AGW	BGW	RF	I		DATE	SCALE	DRWG#
11	--	--	06		12/84	1:5	8

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
11	--	--	06		12/84	1:5	8

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

SINGLE STUD WALL WITH INSULATING SHEATHING
WINDOW HEAD DETAIL

This lintel technique is in keeping with the concept of recessed headers to accommodate high insulation levels. This technique, and variations on it, can reduce thermal bridging across framing members.

Technical Performance:

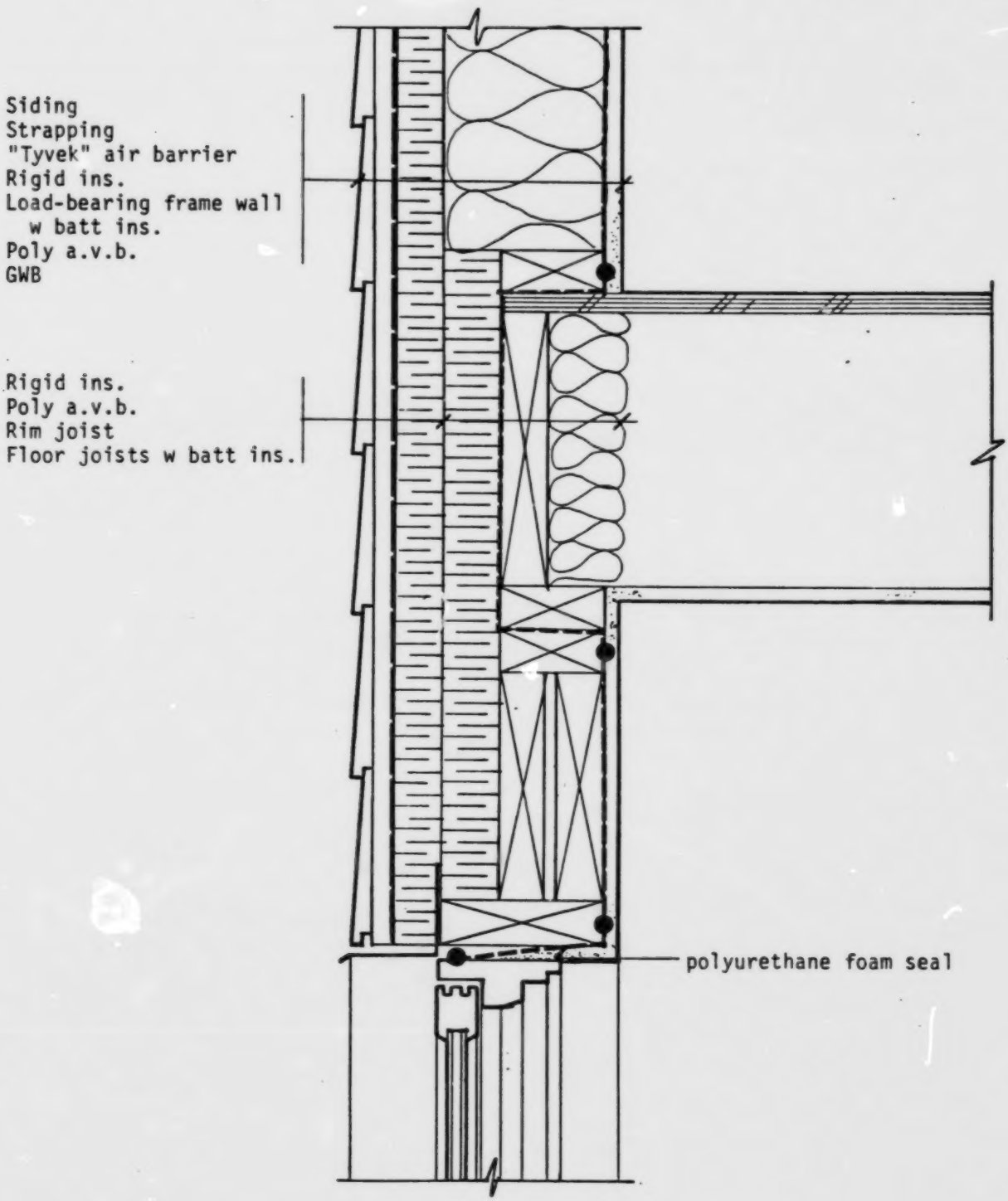
- as drawn an air space exists between the lintels - it would be preferable to fill this space with insulation
- an enlarged wall top plate may be required as a firestop between floors
- the 2x6 plate at the underside of lintel is redundant from a structural perspective

Practical Application:

- wrapping of window with polyethylene can be unwieldy and time consuming unless properly performed
- use of polyurethane foam can result in frame warpage, materials wastage and mess if not carefully installed

AGW	BGW	RF	I		DATE	SCALE	DRWG#
11	--	--	22		12/84	1:5	9

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
11	--	--	22		12/84	1:5	9

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

SINGLE STUD WALL WITH INSULATING SHEATHING
EAVE DETAIL, DROPPED CHORD TRUSS

This roof system allows for both high insulation levels and potentially good airtightness.

Technical Performance:

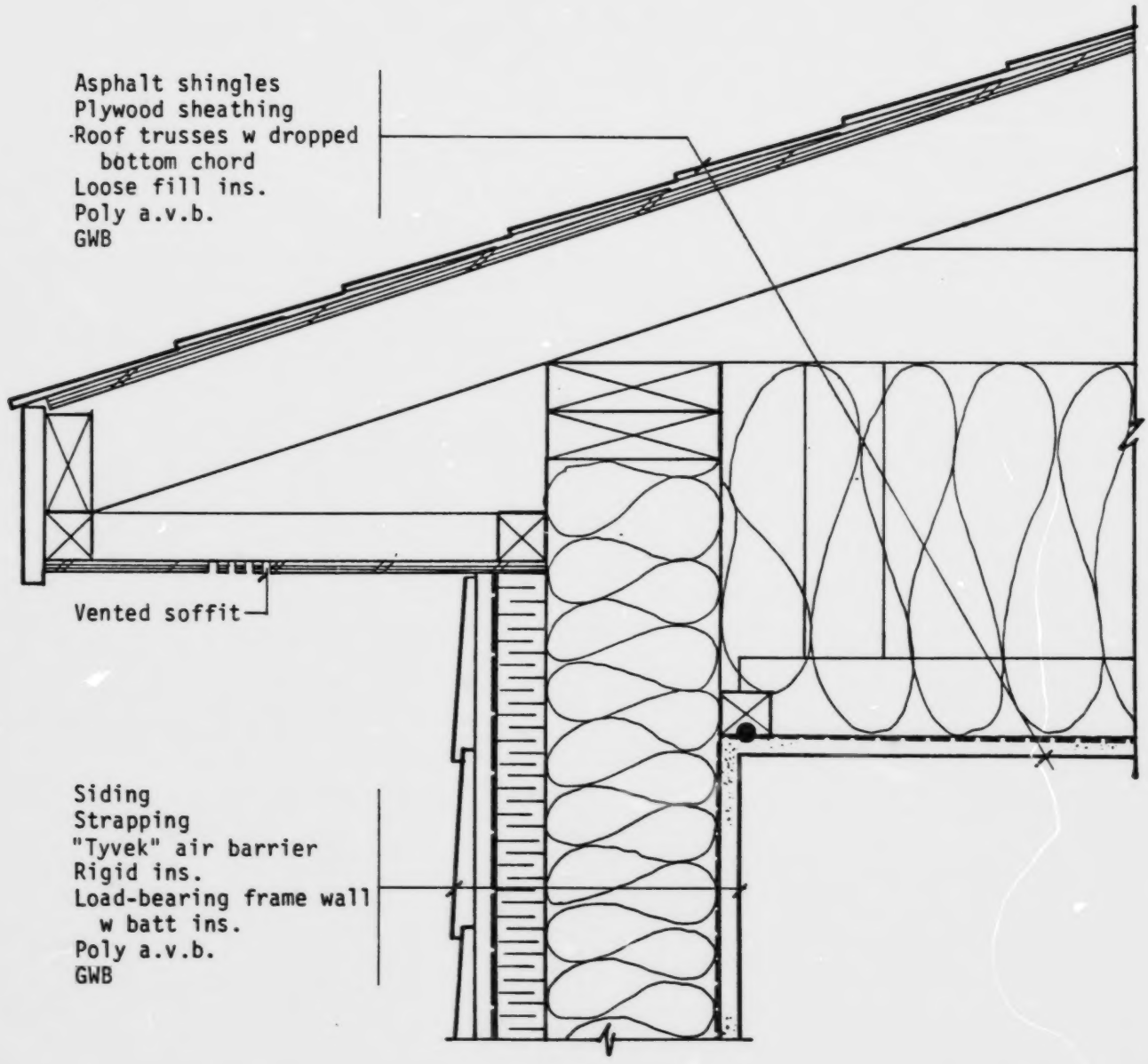
- the system provides high insulation levels across the full area of the roof
- air circulation into the insulated cavity should be kept to a minimum. The insulating sheathing should be extended to the top of the plate
- the dropped chord truss can reduce the likelihood of ceiling damage caused by truss uplift as the entire loadbearing portion of the truss is outside the insulated envelope

Practical Application:

- this system uses longer than standard wall studs if standard ceiling heights are required, and additional material in the truss
- single top plates can be employed if trusses are directly lined up over studs
- 38 x 120 rather than 38 x 89 and 38 x 38 at fascia would reduce labour requirements
- trusses will be heavier and more difficult to manoeuvre than a conventional truss if the dropped chords are factory applied
- if dropped chords are field applied, there will be additional labour requirements

AGW	BGW	RF	I		DATE	SCALE	DRWG#
11	--	32	10		12/84	1:5	10

[illegible] BRENAIR-WHITE LTD. to be used for documentary purposes only



AGW	BGW	RF	I		DATE	SCALE	DRWG#
11	--	32	10		12/84	1:5	10

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

BUILDING SECTION WITH SINGLE FRAME WALL WITH INSULATING SHEATHING AND CONVENTIONAL FRAMING ON CONCRETE FOUNDATION WITH EXTERIOR INSULATION

The building section shown illustrates the following systems:

- concrete foundation with exterior rigid insulation
- conventionally framed single frame wall with batt insulation and double layer of exterior rigid insulating sheathing
- ceiling joists and rafters

The above grade wall system is conventionally framed with 38 x 89 mm studs. The air-vapour barrier is located on the exterior of the plywood sheathing. High levels of insulation are provided by two layers of thick high density insulation which are fastened to the frame with gutter spikes. Services are well separated from the air-vapour barrier.

Nominal RSI: 6.5 Modified RSI: 6.46

System Advantages:

- building can be framed conventionally using standard stock
- RSI levels are maintained at the floor headers, thermal bridging is minimized
- easy to install continuous air-vapour barrier
- wiring and other services do not penetrate the vapour barrier
- exterior strapping provides desirable air space behind the siding
- exterior insulation is used below grade

System Disadvantages:

- siding must be hung from top of wall because spike fasteners may not provide adequate support
- spike fasteners may act as significant thermal bridges particulary if they contact metal siding
- it may be difficult in some regions to get special thick high R rigid insulation
- the cost of rigid insulation may be prohibitive in some regions
- strips of vapour barrier must be installed over the wall top plates
- installation of vapour barrier and rigid insulation is weather dependent
- u.v. stabilized polyethylene is required

All AGW 12 drawings describe this wall type.

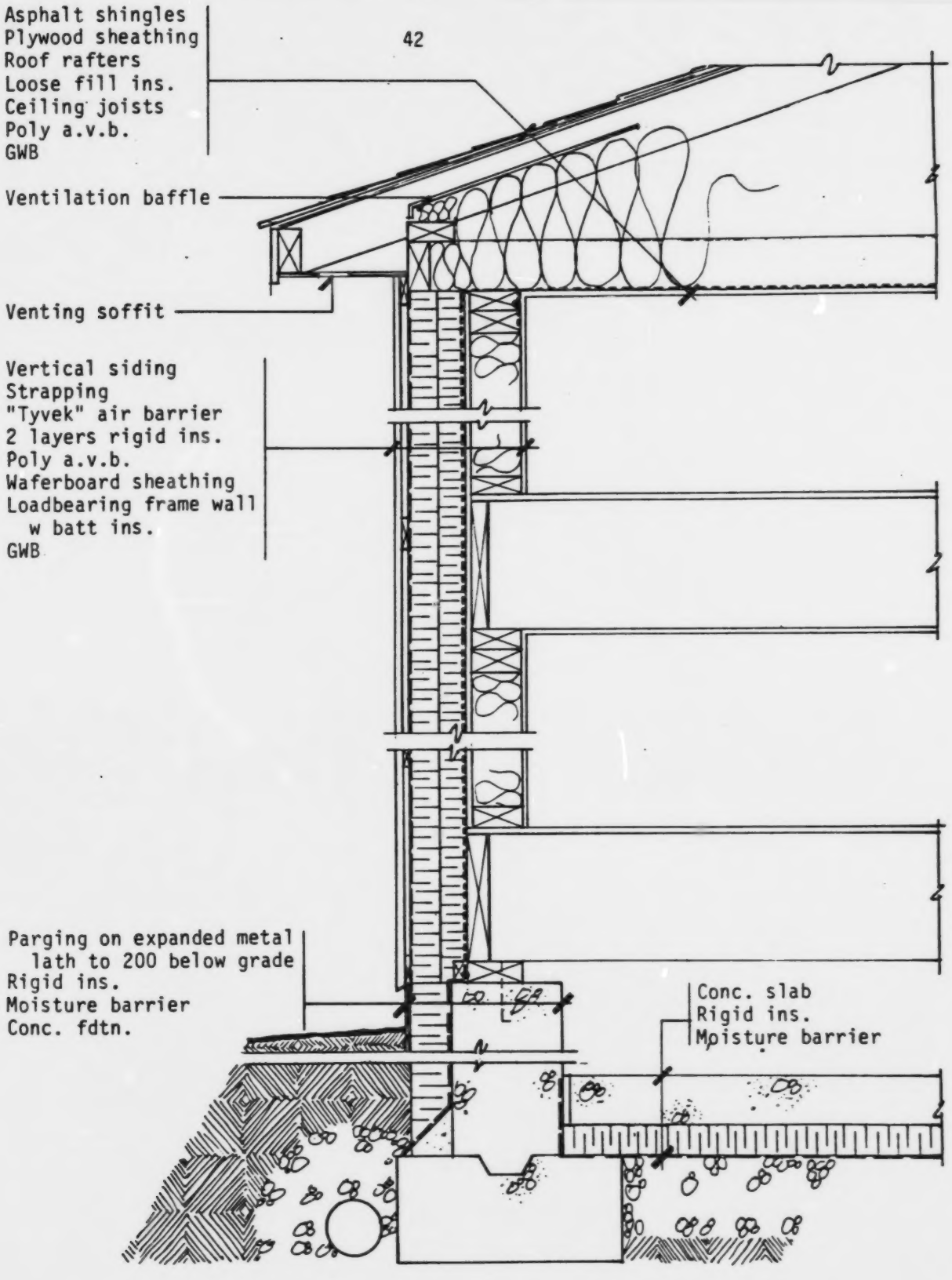
DRAWING #

			12	PLAN OF WALL
		3		FOOTING
			13	SILL
				INTERMEDIATE FLOOR
				WINDOW
			14	EAVE

KEY DETAILS

Refer also to the sections on roofs, openings and penetrations for other applicable details

AGW	BGW	RF	I	DATE	SCALE	DRWG #
12	21	37	--	12/84	1:10	11



AGW	BGW	RF	I		DATE	SCALE	DRWG#
12	21	37	--		12/84	1:10	11

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

SINGLE STUD WALL WITH DOUBLE LAYER OF INSULATING SHEATHING

This system utilizes conventional 38 x 89 framing techniques with a double layer of rigid board insulation outside the vapour barrier and batt insulation in the framed wall.

Technical Performance:

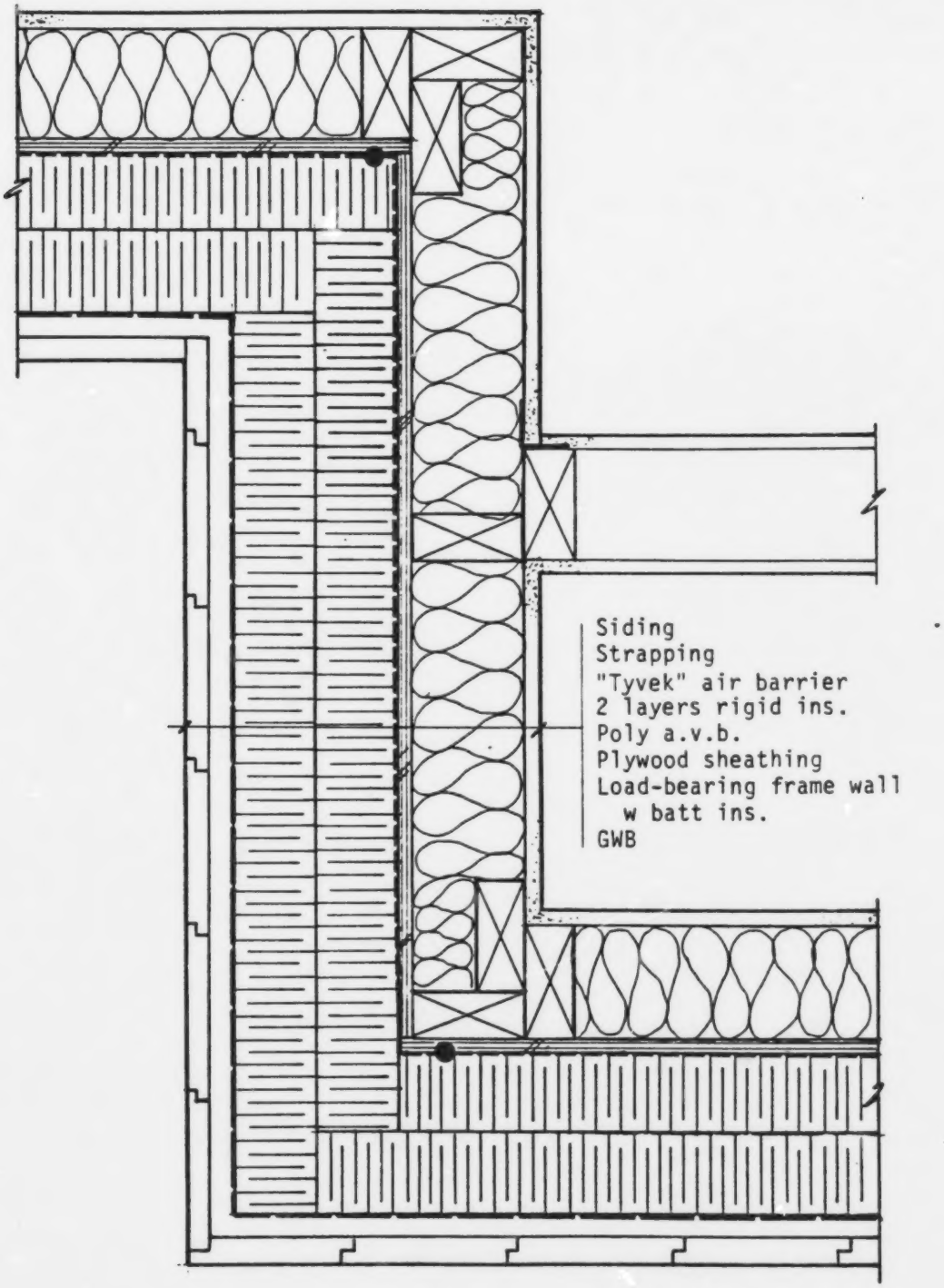
- at least two thirds of the total R value of the wall must be placed on the outside of the a.v.b. This means using one of the more insulative board materials or reducing the insulation in the wall cavity
- the exterior strapping provides a desirable cavity between the siding and exterior insulation
- the polyethylene a.v.b. is well supported and protected between the sheathing and rigid insulation
- the gutter spike fasteners required for the sheathing board and strapping may cause significant thermal bridging, particulary if the nail heads contact metal siding. Intermediate nailers would eliminate this problem and provide better fastening characteristics

Practical Application:

- standard framing techniques are utilized
- the air vapour barrier will be exposed to the elements before the first layer of rigid insulation is applied. U.v. stabilized polyethylene is suggested
- long galvanized nails such as gutter spikes, are required to fasten the exterior strapping to the framing
- the wall cavity allows for electrical services without penetrating the vapour barrier
- the availability and price of special thickness extruded polystyrene will determine the practicality of this method

AGW	BGW	RF	I		DATE	SCALE	DRWG #
12	--	--	07		12/84	1:5	12

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD. to be used for documentary purposes only.



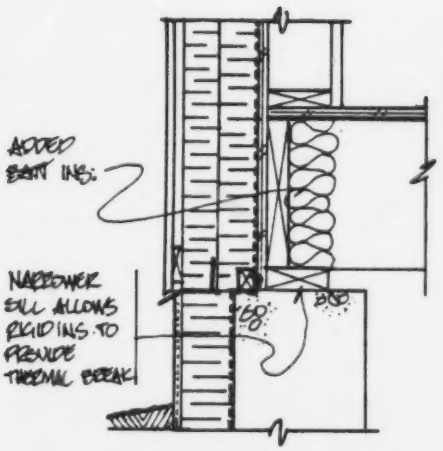
AGW	BGW	RF	I		DATE	SCALE	DRWG#
12	--	--	07		12/84	1:5	12

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

SILL DETAIL, SINGLE FRAME VARIATION WITH EXTERIOR FOUNDATION INSULATION

This detail shows a conventionally framed wall with batt insulation and a double layer of rigid board insulation. The header sits on a concrete foundation insulated on the exterior.

Technical Performance:



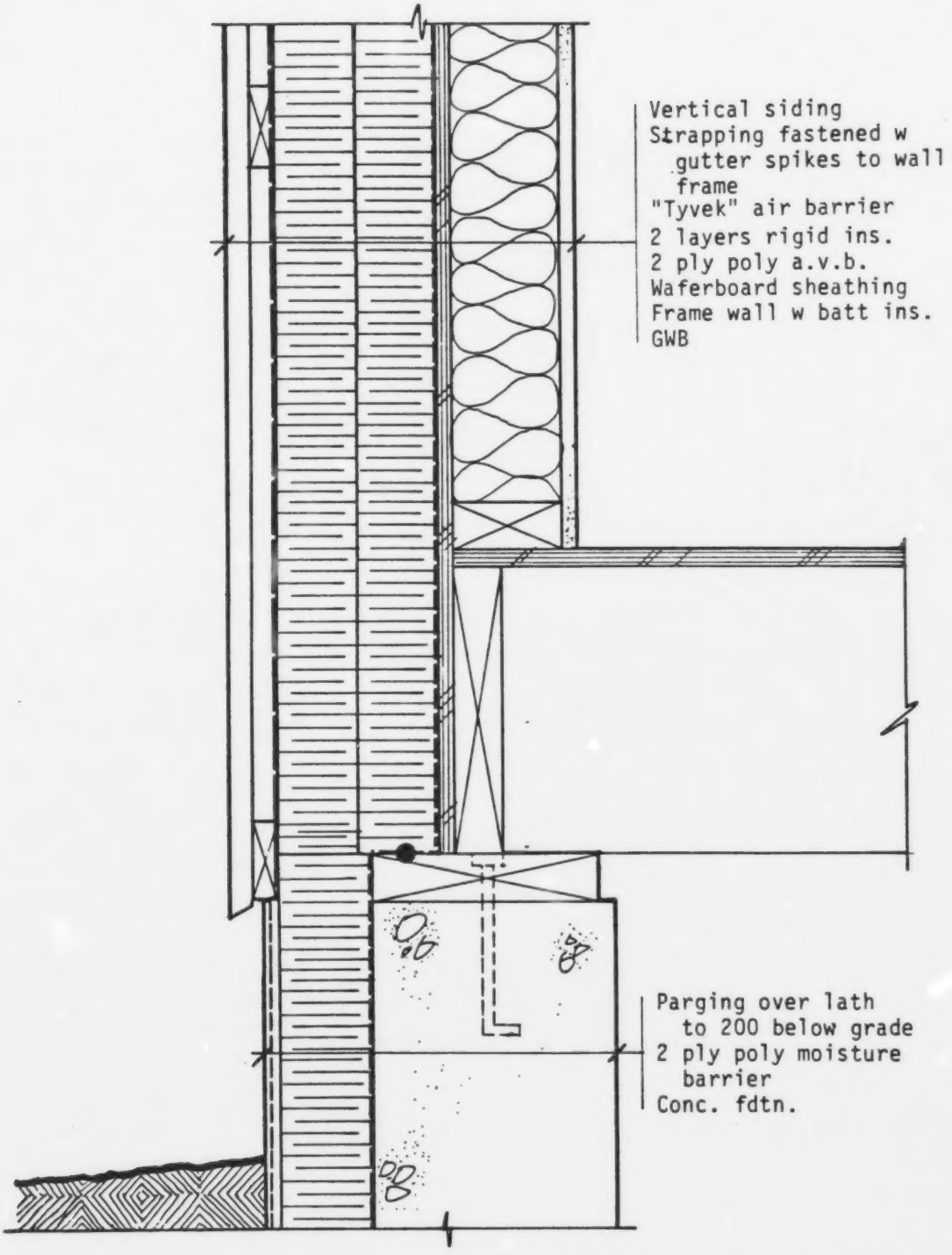
- exterior insulation is used below grade which is the preferred technique
- flashing should be shown at the base of the siding to direct water away from the parging
- the gutter spikes form thermal bridges which may be significant, particularly if they should contact metal siding
- the siding should be fastened securely at the top of the wall
- Intermediate solid nailers would improve fastening characteristics and would reduce thermal bridging
- thermal performance at the header can be improved if batt insulation is fit into the joist space
- if a narrower sill is used the rigid insulation could be continued to the foundation
- a.v.b. should be u.v. stabilized as it will be exposed before the rigid insulation is added

Practical Application:

- standard framing techniques are utilized
- enough moisture barrier must be left at the sill plate for sufficient overlapping with the wall vapour barrier
- long nails have to be used to fasten the rigid insulation both above and at grade
- the system is dependent on the availability and price of extra thick extruded poly-styrene insulation

AGW	BGW	RF	I		DATE	SCALE	DRWG #
12	21	--	01		12/84	1:5	13

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
12	21	--	01		12/84	1:5	13

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD. to be used for documentary purposes only.

- a vertical baffle should be used as an insulation retainer to prevent blow through. This would also allow blown insulation to be used up to the retainer

- if ceiling joists are lined up over the wall studs, only one top plate would be required

Practical Application:

- ceiling drywall should be of adequate thickness to resists sagging

- a strip of polyethylene must be installed over top plate prior to placement of ceiling joists

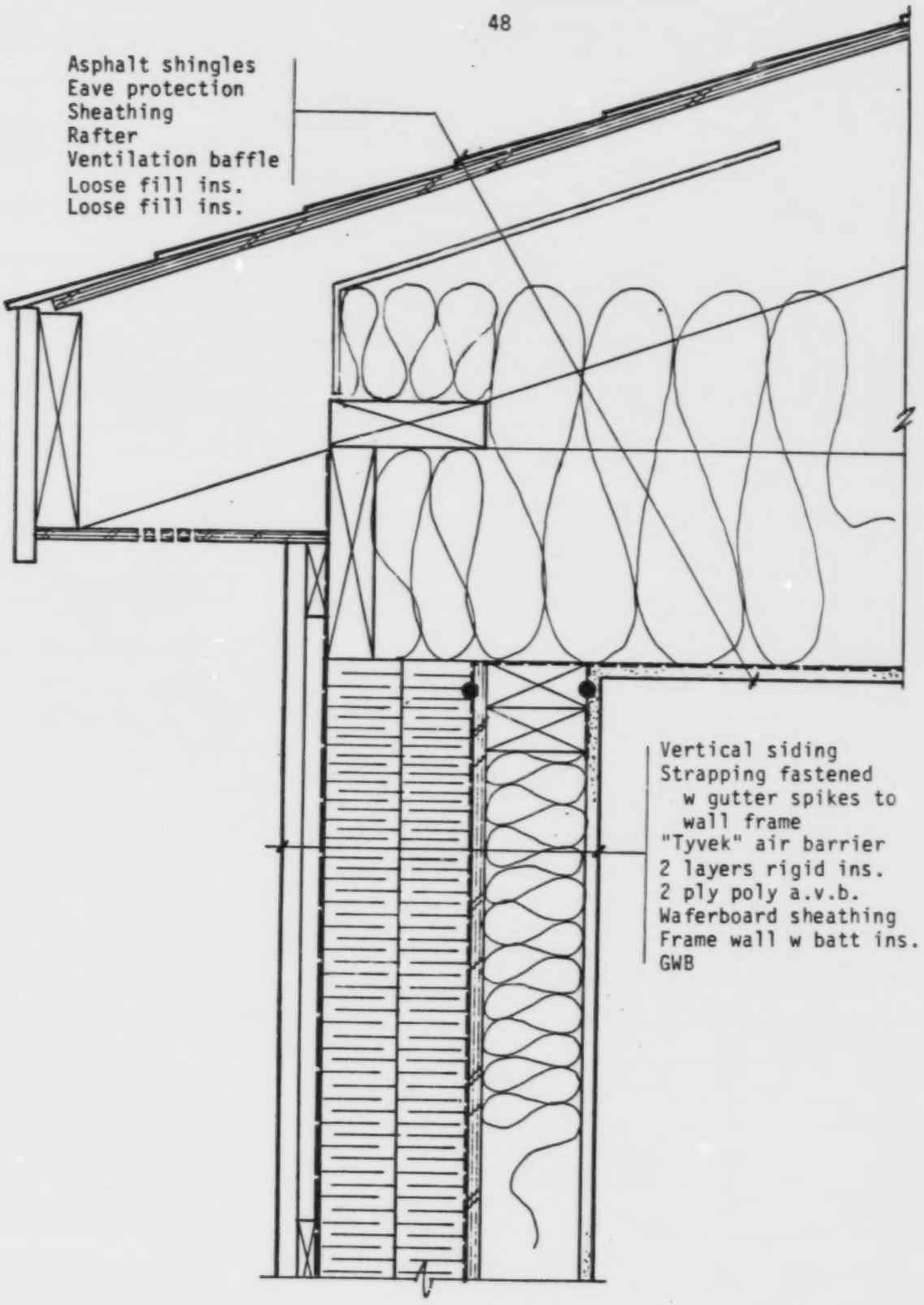
- standard framing techniques are utilized for the walls, ceiling joists and roof rafters

- long galvanized nails such as gutter spikes are used to fasten the exterior strapping

- u.v. stabilized a.v.b. should be used as it will be exposed before the rigid insulation is applied

AGW	BGW	RF	I		DATE	SCALE	DRWG #
12	--	37	10		12/84	1:5	14

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
12	--	37	10		12/84	1:5	14

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

BUILDING SECTION WITH MODIFIED BALLOON FRAMING AND EXTERIOR INSULATING SHEATHING USING DRYWALL AS THE AIR BARRIER

The building section shown shows the following combination of systems:

Preserved wood foundation
Modified balloon frame wall with exterior insulating sheathing
Raised heel truss

The drywall functions as the air barrier and is sealed with gaskets or caulk to the framing at floor junctions. The drywall must be finished with a vapour retarder. Any system in which the air barrier is located at the interior surface may be adapted to the airtight drywall approach.

Nominal RSI: 4.4 Modified RSI: 4.08

System Advantages:

- provides consistent insulation levels
- eliminates the need for a caulked polyethylene a.v.b.

System Disadvantages:

- multiple caulked or gasketed joints occur at floors
- differential shrinkage and movement may open joints over time
- system requires complex trades sequencing: framers, drywallers and electricians

All AGW 13 drawings describe this wall type.

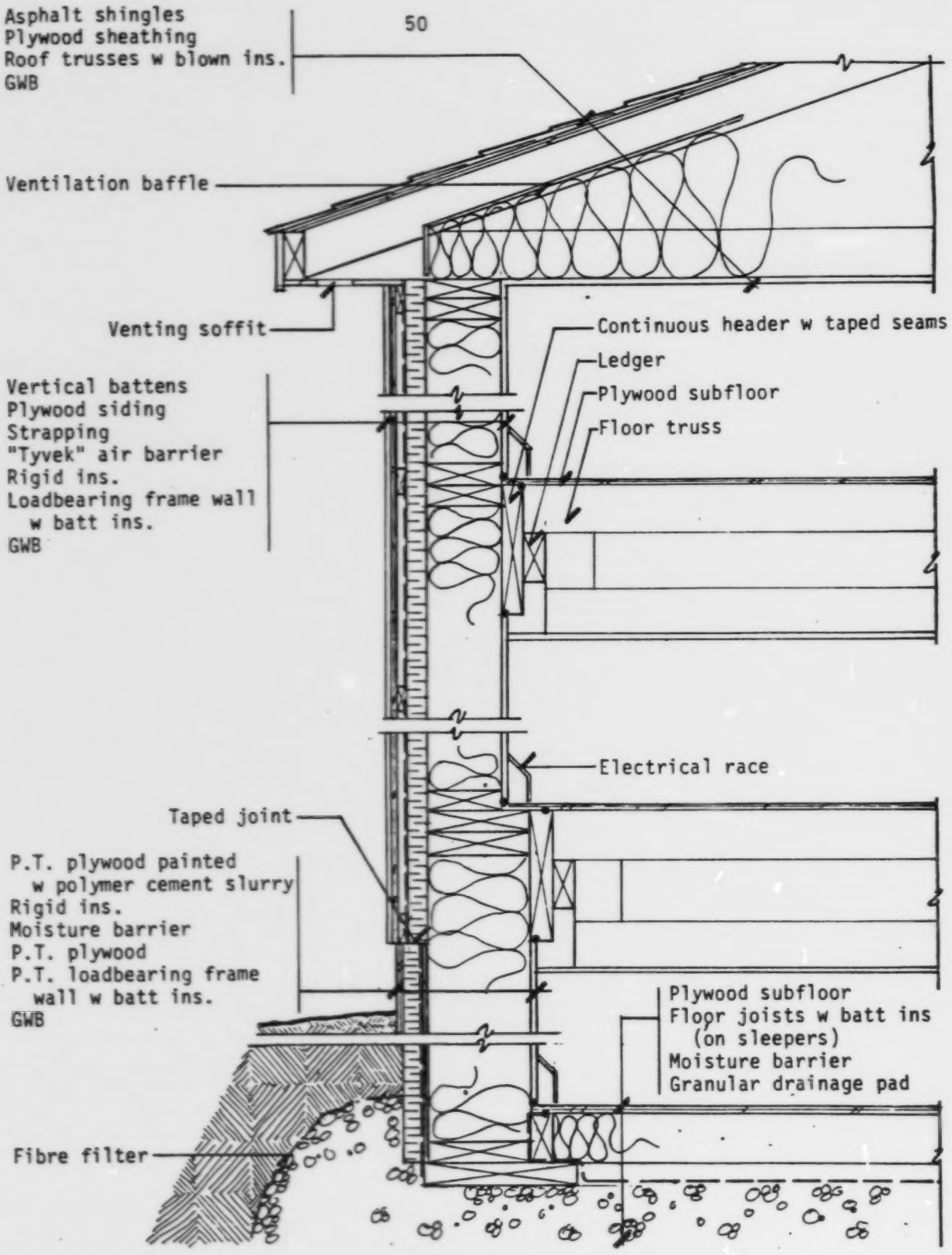
DRAWING #	
16	PLAN OF WALL
17	FOOTING
18	SILL
19	INTERMEDIATE FLOOR
	WINDOW
20	EAVE

KEY DETAILS

Refer also to the sections on roofs, openings and penetrations for other applicable details

AGW	BGW	RF	I		DATE	SCALE	DRWG
13	29	31	--		12/84	1:10	15

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
13	29	31	--		12/84	1:10	15

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

PLAN OF SINGLE STUD WALL WITH INSULATING SHEATHING,
VARIATION USING DRYWALL AS THE AIR-VAPOUR BARRIER

This wall system illustrates the use of the drywall as the main air-vapour barrier with exterior rigid insulating sheathing and wall cavity batt insulation.

Technical Performance:

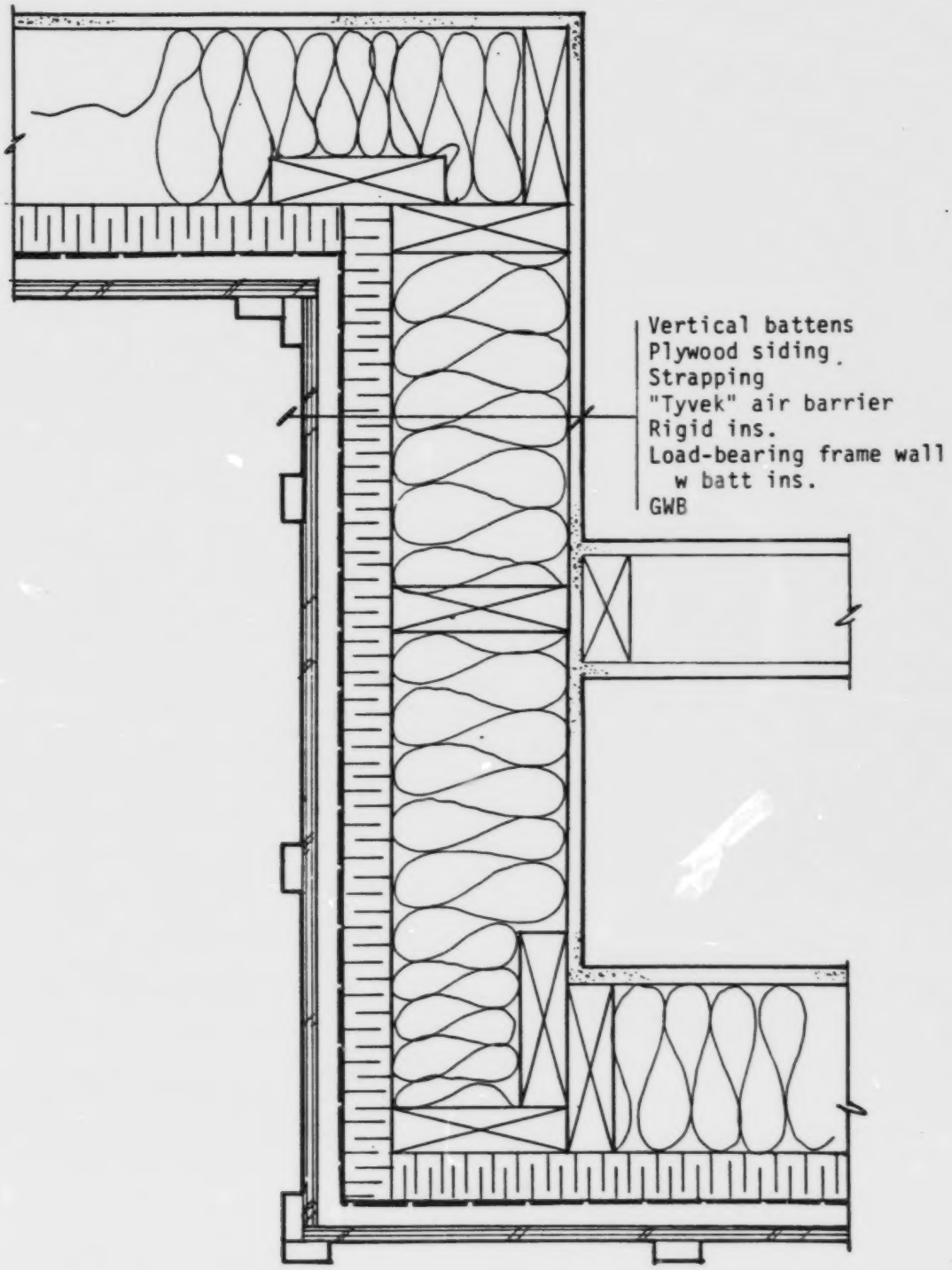
- the air-vapour barrier integrity depends on the drywall joints remaining intact
- a desirable air gap behind the plywood siding is shown
- external air barrier helps prevent convection currents in the wall cavity

Practical Application:

- drywall joints must be carefully sealed with flexible material
- trades must be co-ordinated if conventional wiring is to be used rather than surface wiring
- drywall must be installed and sealed on all insulated walls and ceilings prior to erection of interior partitions and drywalling of non insulated ceilings
- wiring which runs from non insulated walls to insulated walls (or ceilings) creates logistical problems

AGW	BGW	RF	I		DATE	SCALE	DRWG #
13	--	--	07		12/84	1:5	16

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
13	--	--	07		12/84	1:5	16

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

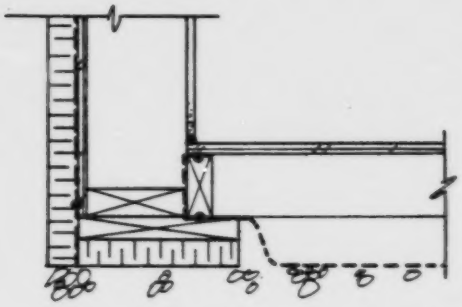
PRESSURE TREATED FOUNDATION WALL AND SLEEPER FLOOR

This detail shows the drywall air-vapour barrier technique combined with pressure treated wood foundation and wood sleeper floor.

Technical Performance:

- preserved wood foundations permit high below grade insulation levels
- some authorities suggest a high density polystyrene board be placed beneath the footing to provide additional moisture protection
- plywood sub-floor should be caulked to the floor header and floor header caulked to the footing

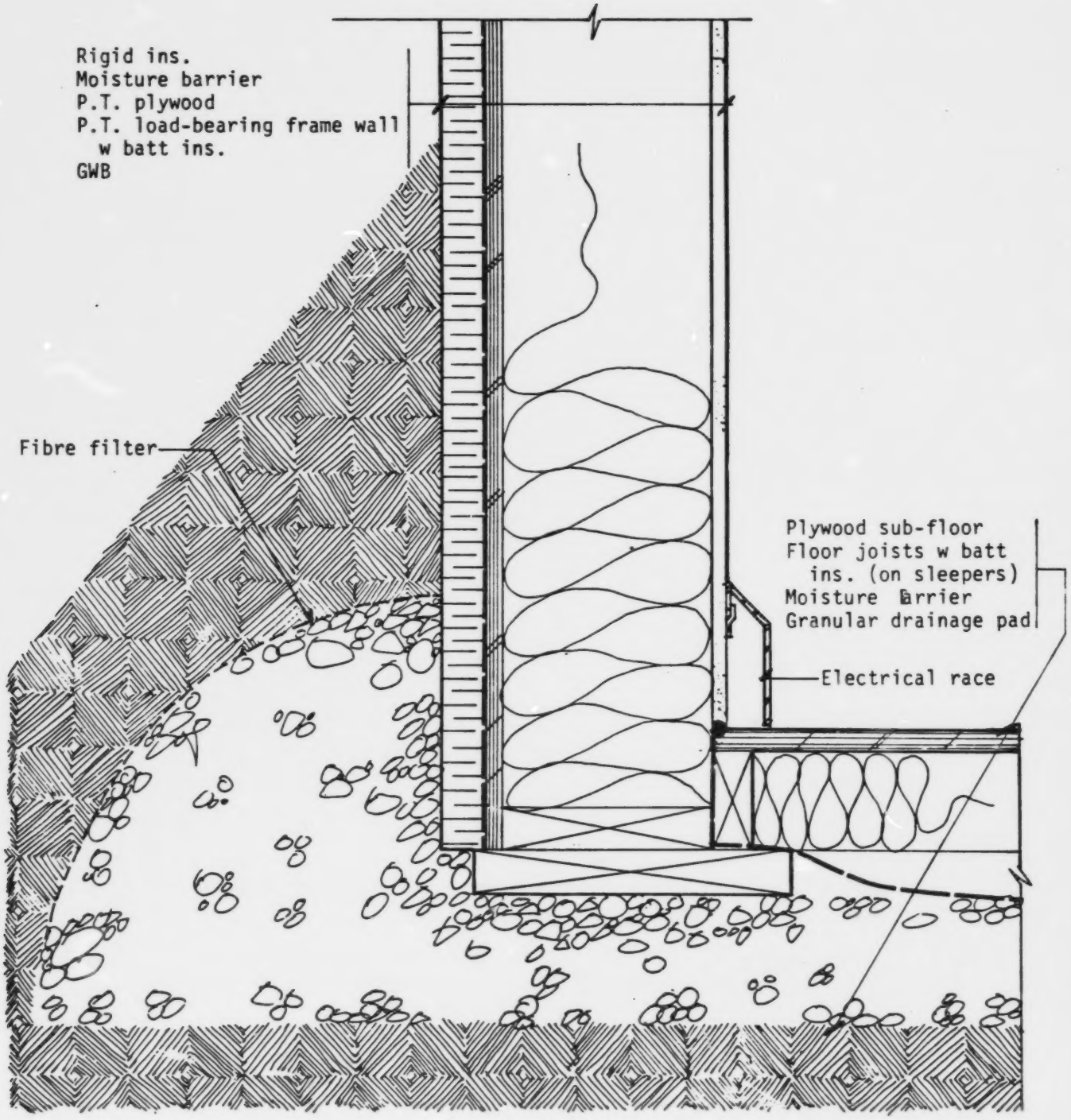
Practical Application:



- eliminates need for on-site concrete thus allowing for cold weather construction
- any field cutting of lumber will require that cut surfaces be thoroughly saturated with preservative as per manufacturers' instructions
- subsoil underneath gravel should be sloped towards the sump, if this method is used to drain the foundation
- polyethylene has to be laid on ground and led partially up the foundation before the floor is assembled
- exterior sheathing should be sealed to the bottom plate

AGW	BGW	RF	I		DATE	SCALE	DRWG #
--	29	--	03		12/84	1:5	17

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
--	29	--	03		12/84	1:5	17

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

SILL DETAIL OF SINGLE STUD WALL VARIATION ON
PRESERVED WOOD FOUNDATION

This variation uses the drywall as the air-vapour barrier.

Technical Performance:

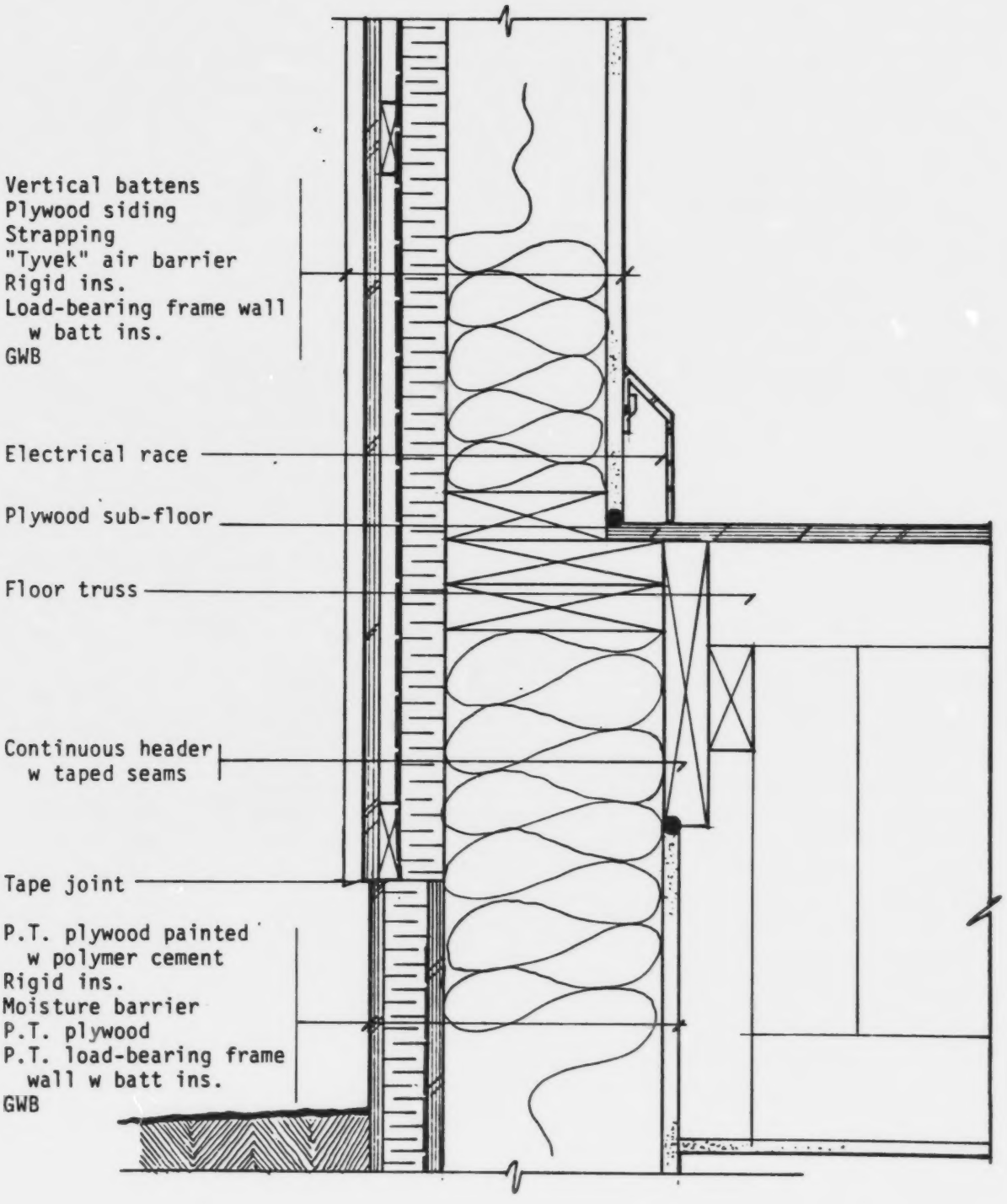
- the structural integrity of the ledger support is unknown, fasteners should be specified
- the integrity of the air-vapour barrier is dependent on careful fitting and sealing of the drywall to the subfloor and header. Shrinkage, checking or splitting would damage the air-vapour barrier
- subfloor must be sealed to the header (not shown)
- flashing should be added at the base of the exterior sheathing to protect the finish of the above grade foundation
- the drywall must be finished with a vpour retarder

Practical Application:

- nailing pattern at the ledger must be specified and inspected before the trusses are installed
- careful attention must be paid to sealing the drywall to the header and subfloor
- availability and price of electrical race will determine if this method can be used to run electricals
- any penetrations in the drywall and joints in wall plates and headers must be sealed
- many options are available for vapour retarders at the drywall e.g. special paints, combinations of conventional points, some wallpapers

AGW	BGW	RF	I		DATE	SCALE	DRWG#
13	29	--	01		12/84	1:5	13

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
13	29	--	01		12/84	1:5	18

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

INTERMEDIATE FLOOR JUNCTION WITH FULLY INSET HEADER, "DRYWALL" SYSTEM

This system consists of a floor truss supported on a ledger with an inset header. The taped and caulked or gasketed drywall is used as the air-vapour barrier.

Technical Performance:

- the structural integrity of the ledger support and loading at the lower chord ceiling drywall to wall drywall is unknown
- the air-vapour barrier integrity depends on the seals of the drywall and header
- external strapping provides a desirable air space behind the siding

Practical Application:

- nailing pattern for the ledger must be specified and inspected
- drywall must be fit to close tolerances and carefully caulked or gasketed
- all joints at the header must be sealed
- wall drywall must be installed and taped and sealed prior to ceiling drywall

AGW	BGW	RF	I		DATE	SCALE	DRWG#
13	--	--	06		12/84	1:5	19

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

EAVE RAISED HEEL TRUSS ON SINGLE FRAME WALL VARIATIONS

This detail shows a raised heel truss supported by single frame wall where the drywall is used as the air-vapour barrier.

Technical Performance:

- if the roof trusses are lined up over the wall studs only one top plate would be required
- exterior strapping provides a desirable air space behind the siding
- the integrity of the drywall air-vapour barrier joints determine the success of this system. Checking or warping of wood could lead to air leakage

Practical Application:

- drywall must be installed and taped prior to partitions being framed
- electricals must be roughed in in the ceiling and exterior walls prior to installation of wall board
- penetrations in the drywall must be carefully sealed
- a number of options are available for vapour retarders e.g. 2 mil poly, foil backed drywall, vapour retarding paint or combination of conventional paints

AGW	BGW	RF	I		DATE	SCALE	DRWG#
13	--	31	10		12/84	1:5	20

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

EAVE RAISED HEEL TRUSS ON SINGLE FRAME WALL VARIATIONS

This detail shows a raised heel truss supported by single frame wall where the drywall is used as the air-vapour barrier.

Technical Performance:

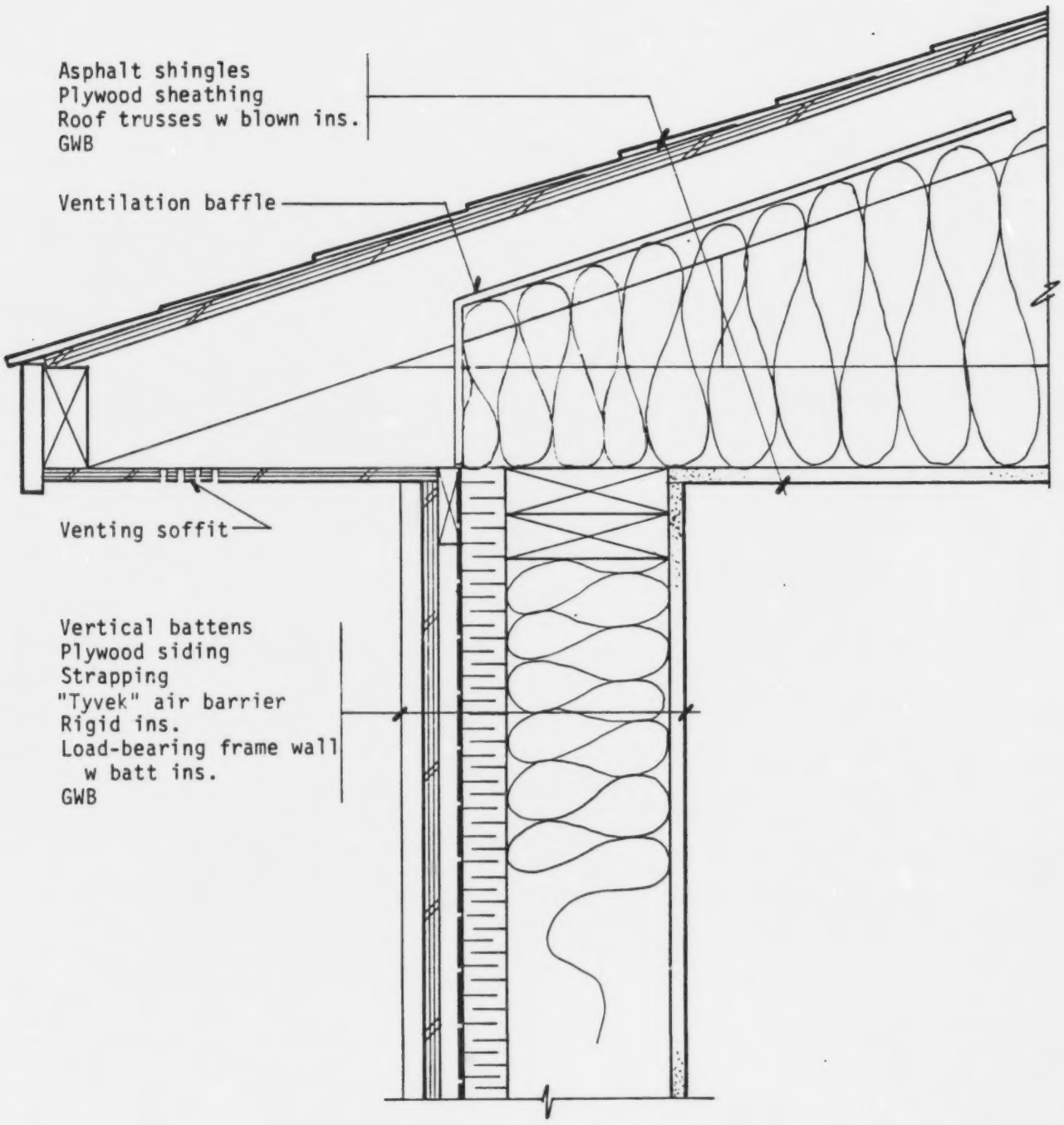
- if the roof trusses are lined up over the wall studs only one top plate would be required
- exterior strapping provides a desirable air space behind the siding
- the integrity of the drywall air-vapour barrier joints determine the success of this system. Checking or warping of wood could lead to air leakage

Practical Application:

- drywall must be installed and taped prior to partitions being framed
- electricals must be roughed in in the ceiling and exterior walls prior to installation of wall board
- penetrations in the drywall must be carefully sealed
- a number of options are available for vapour retarders e.g. 2 mil poly, foil backed drywall, vapour retarding paint or combination of conventional paints

AGW	BGW	RF	I		DATE	SCALE	DRWG #
13	--	31	10		12/84	1:5	20

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
13	--	31	10		12/84	1:5	20

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

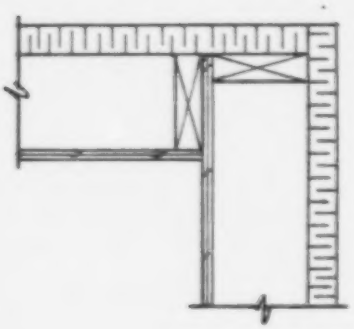
SINGLE STUD WITH INTERIOR INSULATING SHEATHING

This system combines conventional framing techniques with a caulked and taped non-permeable rigid board insulation as the air-vapour barrier.

Technical Performance:

- airtightness and moisture protection depends on the integrity of the joints of the taped and caulked rigid board insulation
- installation of electrical services can damage the air-vapour barrier
- sealing at floor and ceiling junctions must be done carefully to maintain a continuous air-vapour barrier

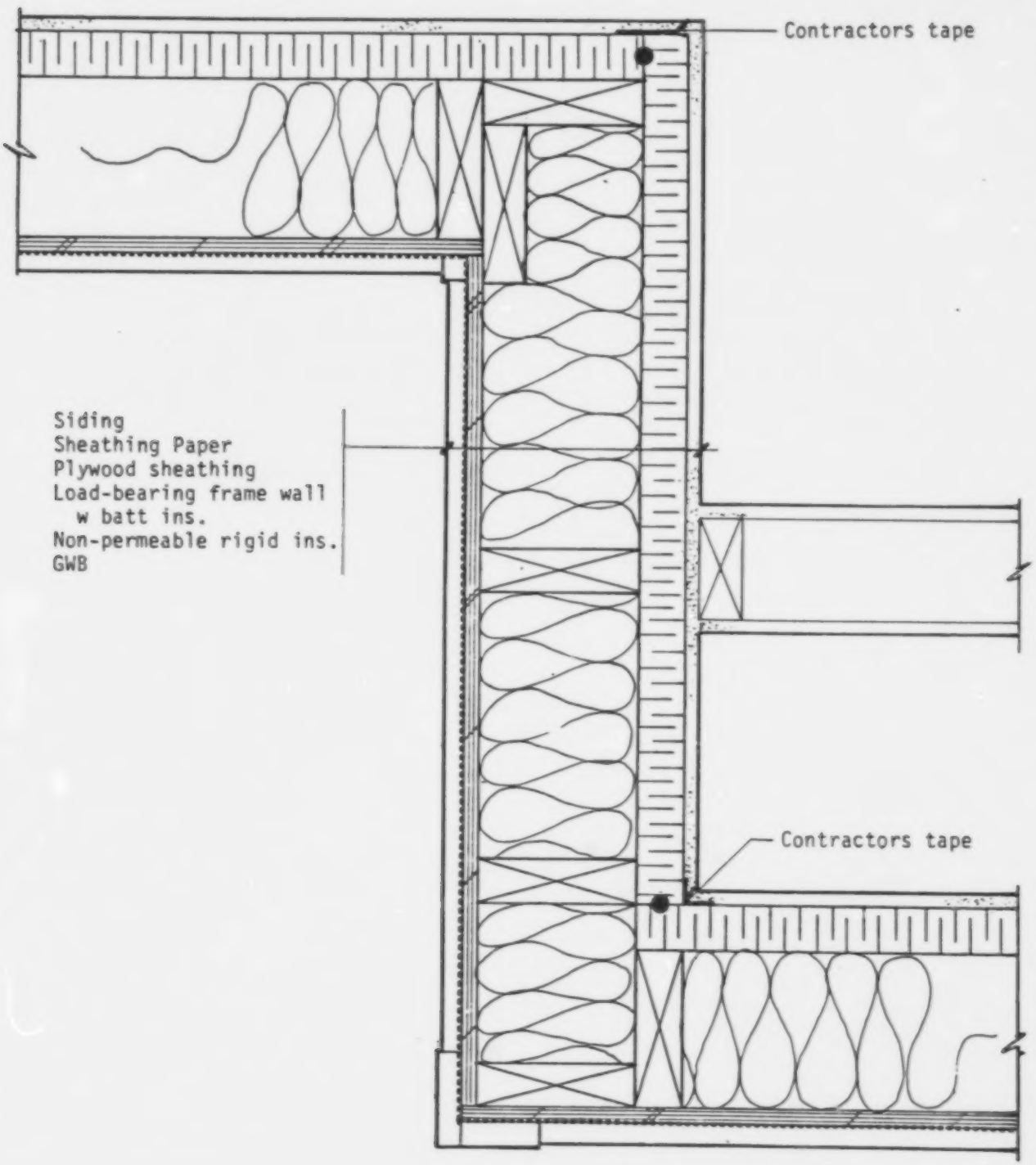
Practical Application:



- rigid board insulation must be cut to fit accurately to ensure the edge joints can be caulked and taped securely
- joints and corners have to be carefully sealed to ensure a continuous air-vapour barrier
- all electricals must be carefully sealed to maintain the air-vapour barrier
- corner blocking could be eliminated at inside corners if the exterior sheathing is continued to the interior wall insulation sheathing
- end studs of interior partitions must be adequately fastened to exterior wall studs

AGW	BGW	RF	I		DATE	SCALE	DRWG
14	--	--	07		12/84	1:5	21

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG #
14	--	--	07		12/84	1:5	21

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

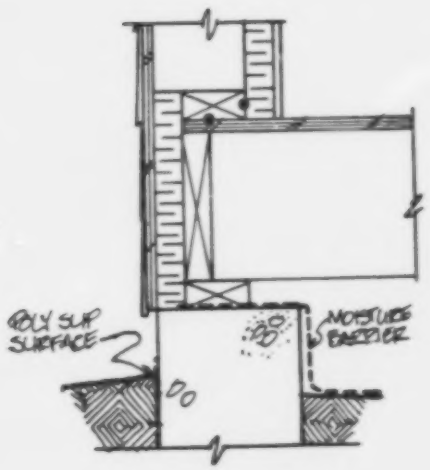
INSULATED WOOD FLOOR OVER UNHEATED CRAWLSPACE WITH SINGLE STUD WALL VARIATION

This detail shows conventional framing with non-permeable rigid insulation as the air-vapour barrier.

Technical Performance:

- air sealing can be improved by caulking the base plate to the sub floor and the rigid insulation to the base plate
- a 38 x 89 base plate and sill could be used which allows the rigid insulation to be extended providing a thermal break
- sill plate should be pressure treated wood
- in colder climates, the foundation wall should have draining insulation or polyethylene sheet attached on either side below grade to prevent adhesion freezing

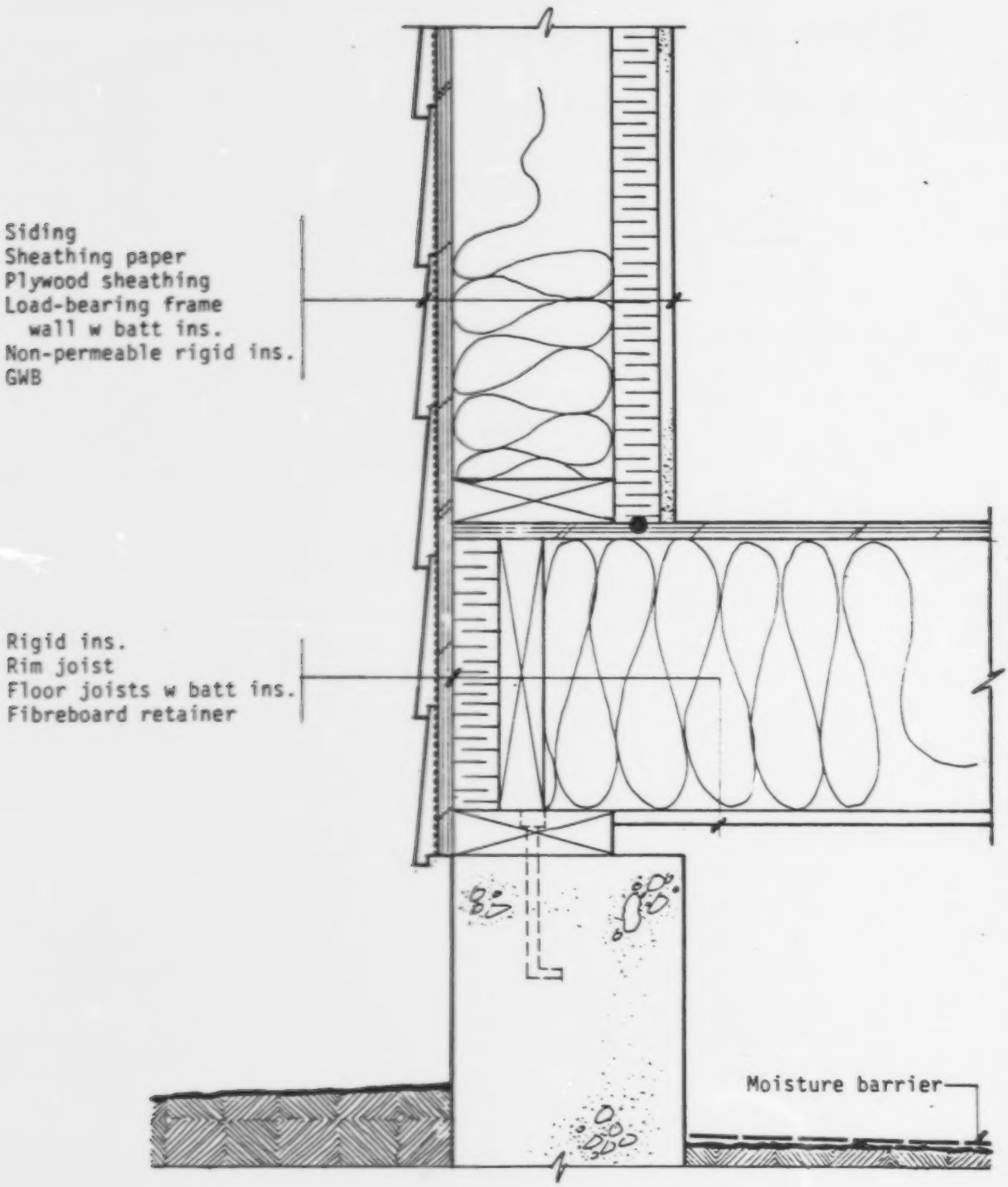
Practical Application:



- service penetrations in the wall must be carefully sealed
- the crawlspace floor moisture barrier should be draped over the foundation before the sill plate is fastened
- any electricals which penetrate the bottom plate must be sealed
- plywood subfloor must be air sealed with caulk or adhesive

AGW	BGW	RF	I		DATE	SCALE	DRWG #
14	20	--	01		12/84	1:5	22

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
14	20	--	01		12/84	1:5	22

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

WINDOW DETAIL FOR SINGLE FRAME WALL
WITH INTERIOR INSULATING SHEATHING

The window is installed in a conventional fashion and sealed to the rough stud opening with polyurethane foam. A finish stip of plywood covers the edge of the rigid board insulation.

Technical Performance:

- since there is no backing above the rough stud opening the polyurethane foam may not completely fill the cavity
- blocking is required at the head and jamb to support the plywood window frame and prevent separation of the rigid insulation/plywood joint
- a single header may be structurally adequate, depending on loading

Practical Application:

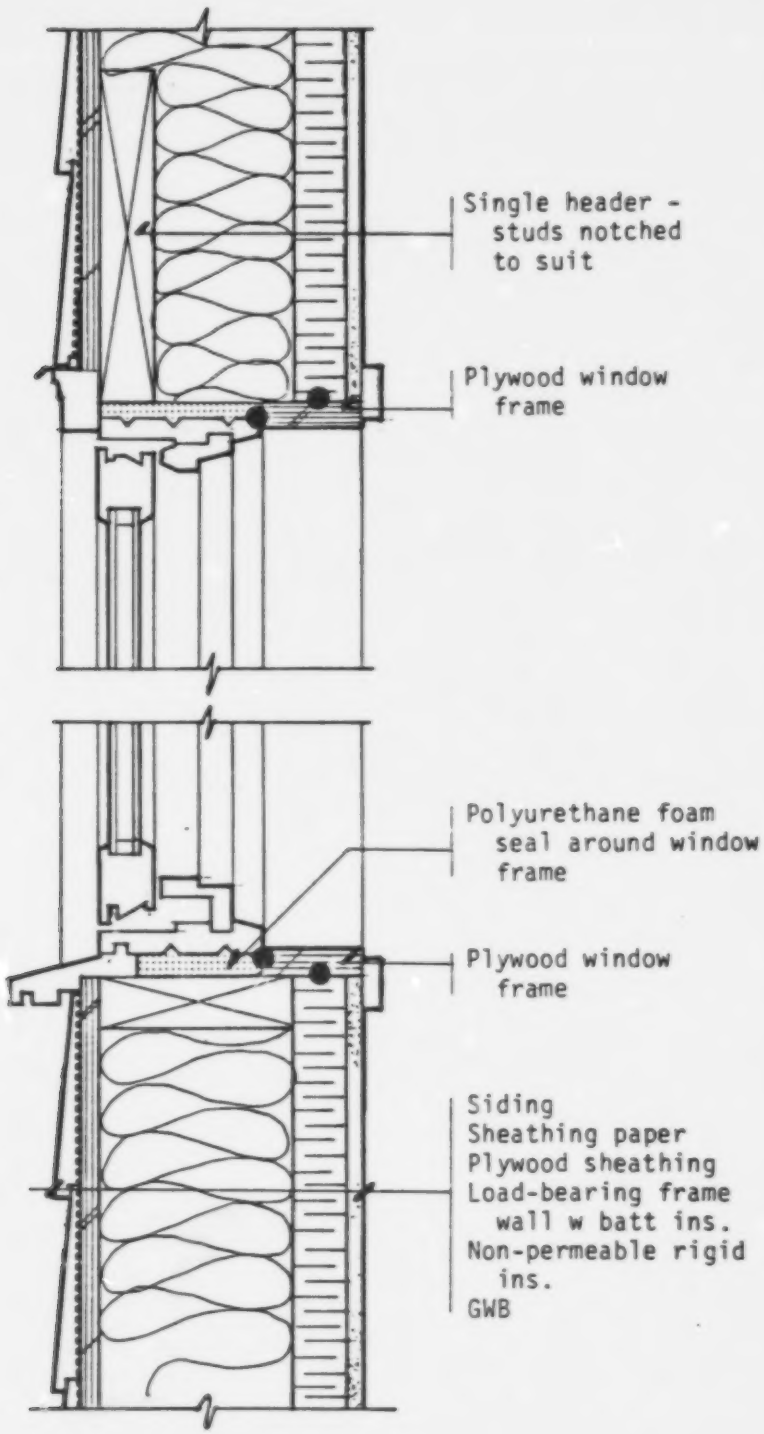
- studs have to be notched to accept the single header
- a backer block is required for the polyurethane foam at the lintel
- blocking should be installed for finish trim and drapery rod hanging

AGW	BGW	RF	I		DATE	SCALE	DRWG #
14	--	--	22		12/84	1:5	23

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

HEAD

SILL



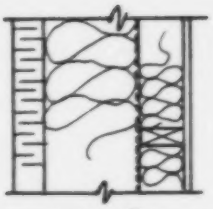
AGW	BGW	RF	I		DATE	SCALE	DRWG#
14	--	--	22		12/84	1:5	23

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

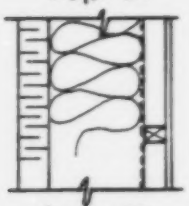
SINGLE FRAME SYSTEMS WITH INTERIOR STRAPPING

Single frame walls may be upgraded by applying horizontal strapping on the inside of the studs over a polyethylene air-vapour barrier. The strapping permits better airtightness by providing a chase for wiring and other services inside the air-vapour barrier and creates a cavity for additional insulation. Interior strapping is usually used in conjunction with exterior insulating sheathing and is sometimes referred to as the 'wrap and strap' technique. Although it is a single frame system, the 'wrap and strap' technique can be as complex as thick wall systems in terms of materials, number of passes over the wall and trades co-ordination.

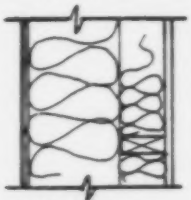
Depending on the thickness of the studs, the strapping and the thickness and type of sheathing board used, nominal R values range from about R 4 to R 6. Actual R values may be assumed to be about 10% less than nominal in most cases.



AGW 21



AGW 22



AGW 23

The following section documents three variations of this system:

AGW 21 drawings show a wrap and strap system using 64 mm strapping.

AGW 22 drawings show a wrap and strap system, modified balloon frame, using 38 mm strapping

AGW 23 drawings show interior 64 mm strapping with conventional sheathing

The latter system does not include a full building section.

Observations:

1. The air-vapour barrier must remain above dew point temperatures which means, normally, that at least two thirds of the total R value of the wall must be placed on the outside of the air-vapour barrier.

2. All joints in the polyethylene air-vapour barrier must be sandwiched between solid materials. This requires foresight in locating the seams.

BUILDING SYSTEM USING SINGLE STUD WALL VARIATION WITH EXTERIOR INSULATING SHEATHING AND INTERIOR STRAPPING WITH INSULATION

The building section shown shows the following systems:

- Concrete foundation with exterior rigid insulation
- Modified platform frame wall with rigid exterior insulating sheathing and interior 38 x 64 strapping with batt insulation
- Raised heel standard truss

The above grade wall system is a modified platform frame which the rim joists are partially inset to permit the placement of rigid insulation at the floor bands. This detail also allows for insulation between the horizontal 38 x 64 mm strapping on the inner side of the sealed polyethylene which provides a wiring box space inside the vapour barrier.

Nominal RSI: 5.9 Modified RSI: 5.5

System advantages:

- wiring does not penetrate the vapour barrier and drilling for wiring is reduced
- system uses standard length stock
- single frame system may be erected and closed in rapidly so that air sealing and strapping occurs under weather protected conditions
- increased insulation levels achieved by using the strapping in space for batt insulation
- the secondary air barrier helps reduce convection losses within the wall cavity
- exterior horizontal strapping provides desirable air space behind the siding

System Disadvantages:

- insulation levels are reduced at rim joists, particularly if 38 x 89 are used
- lack of insulatiofn at rim joist area may lead to condensation risk
- let in diagonal bracing must be provided.
- strips of polyethylene must be installed around floor headers and is subject to damage if care is not taken

DRAWING #

			25
		26	3
	28	27	
		30	29
			31

KEY DETAILS

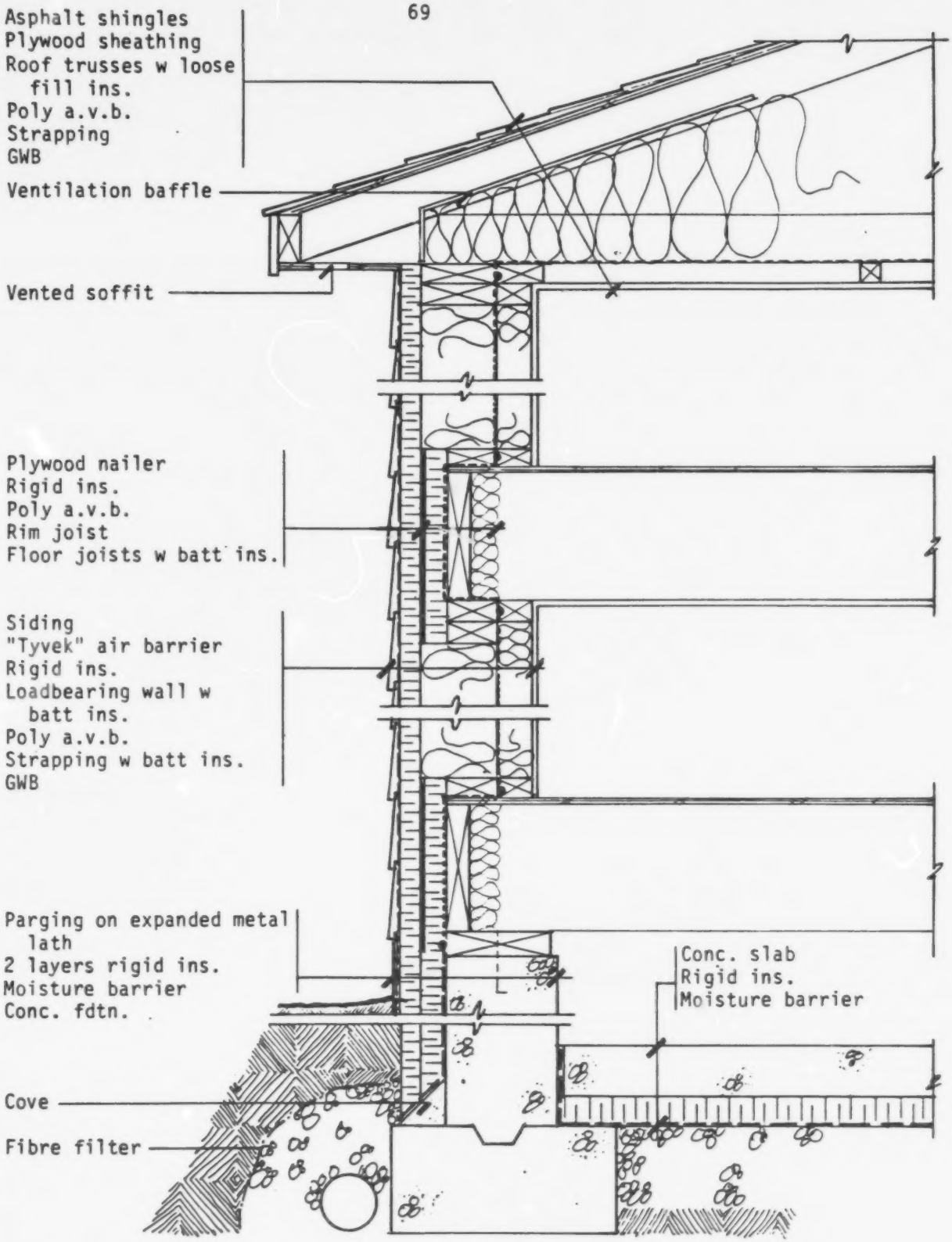
All AGW 21 drawings describe this wall type.

PLAN OF WALL
FOOTING
SILL
INTERMEDIATE FLOOR
WINDOW
EAVE

Refer also to the sections on roofs, openings and penetrations for other applicable details

AGW	BGW	RF	I		DATE	SCALE	DRWG#
21	21	31	--		12/84	1:10	24

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
21	21	31	--		12/84	1:10	24

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

SINGLE STUD, WRAP & STRAP VARIATION
USING 38 X 64 MM STRAPPING

This system, illustrating a three stud corner detail, provides good thermal and airtightness characteristics and is simple to build. Though vapour barrier installation is not difficult, care is required to ensure it is not misapplied.

Technical Performance:

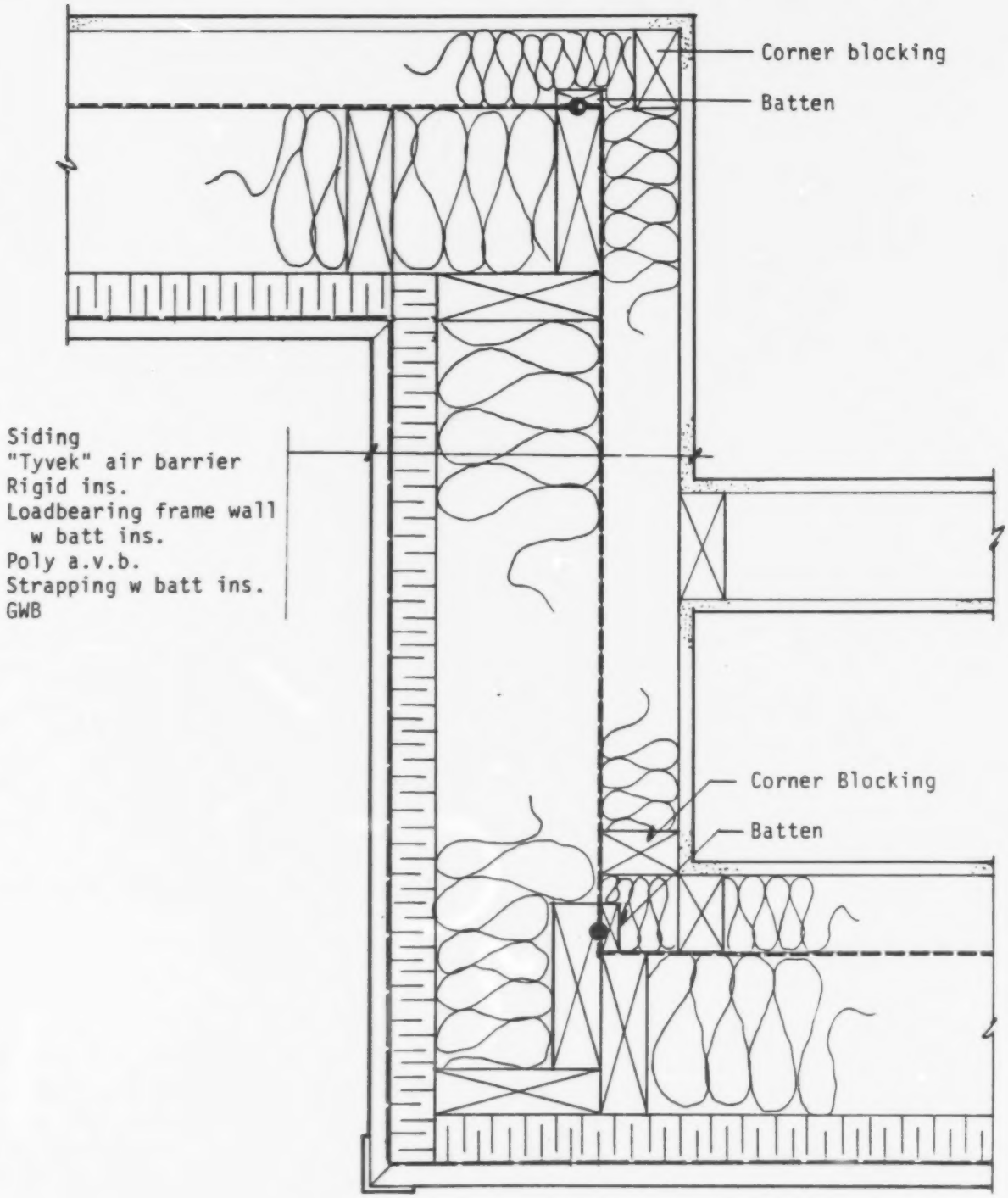
- an effective vapour barrier is provided
- battens provide structural support at the corners for the vapour barrier
- the use of a secondary air barrier (Tyvek™) reduces convective air movement in the wall cavity batt insulation
- corner blocking gives a good fastening surface for the drywall

Practical Application:

- insulation has to be inserted in corner cavities
- strapping is claimed to be easy to work with and work is not weather dependent

AGW	BGW	RF	I		DATE	SCALE	DRWG#
21	--	--	07		12/84	1:5	25

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD. to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
21	--	--	07		12/84	1:5	25

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

PRESERVED WOOD FOUNDATION WITH INTERIOR CROSS STRAPPING

This footing detail illustrates standard preserved wood foundation techniques with the addition of interior cross strapping.

Technical Performance:

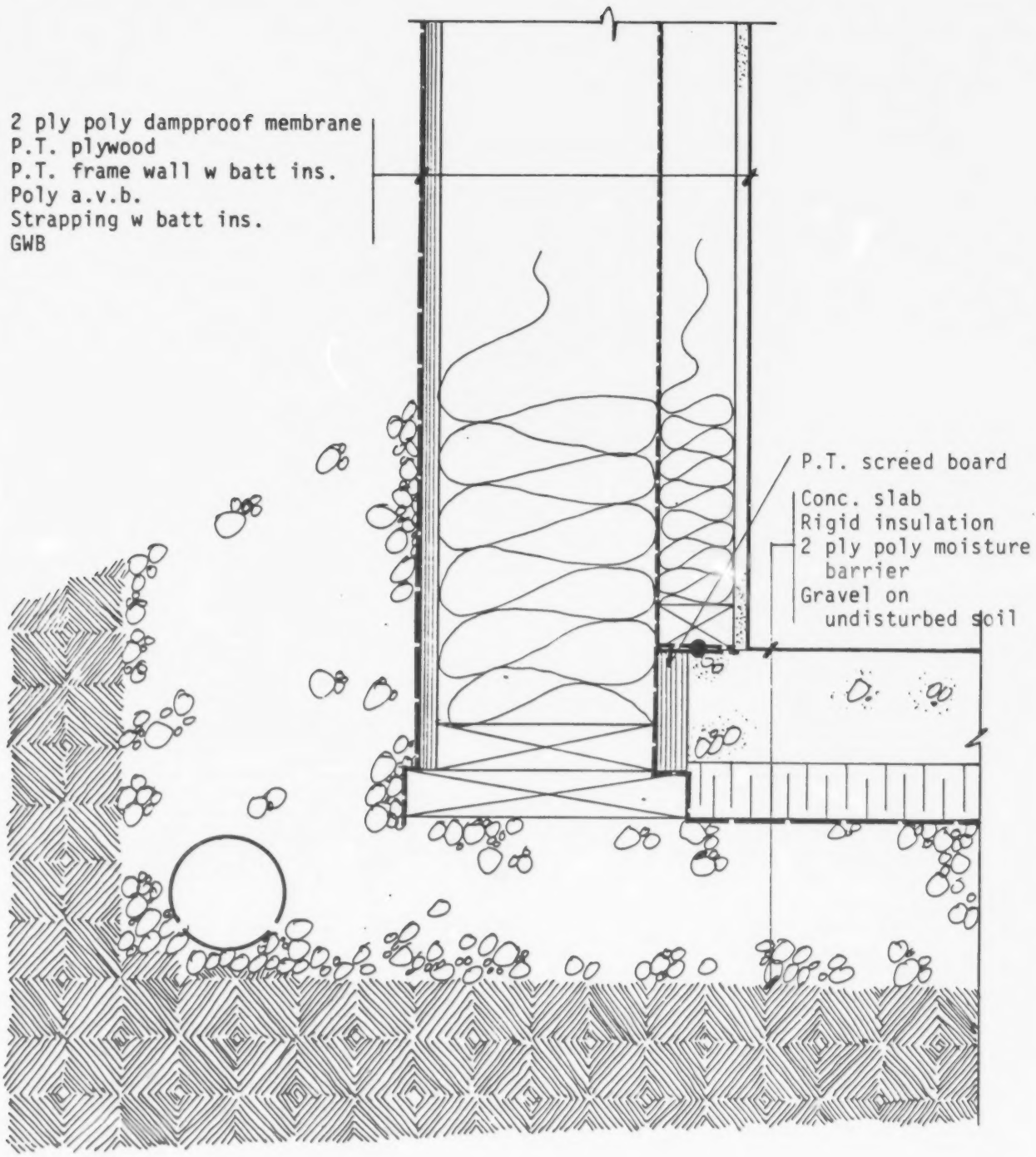
- the crushed gravel drainage layer reduces the likelihood of standing water in contact with the foundation wall or rigid insulation
- free draining backfill is strongly recommended to minimize frost action
- the installation of interior cross strapping reduces the effect of thermal bridging across the wall studs
- the cross strapping allows the interior polyethylene to remain intact by providing a chase for electrical and plumbing runs
- some authorities recommend the use of extruded polystyrene under the footing for increased moisture protection

Practical Application:

- some trouble can be experienced in levelling the gravel drainage layer for the preserved wood sleeper footing
- allows the use of a framing crew at the commencement of the job
- sourcing of metal fasteners as specified by CSA (stainless steel nails and straps) can be difficult
- polyethylene moisture barrier must be protected during backfill

AGW	BGW	RF	I		DATE	SCALE	DRWG #
--	29	--	03		12/84	1:5	26

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
--	29	--	03		12/84	1:5	26

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

SILL DETAIL, SINGLE FRAME WALL ON CONCRETE FOUNDATION WITH INTERIOR INSULATION

Insulation levels in this detail are good but provide poor airtightness. The below grade batt insulation is poorly protected from moisture.

Technical Performance:

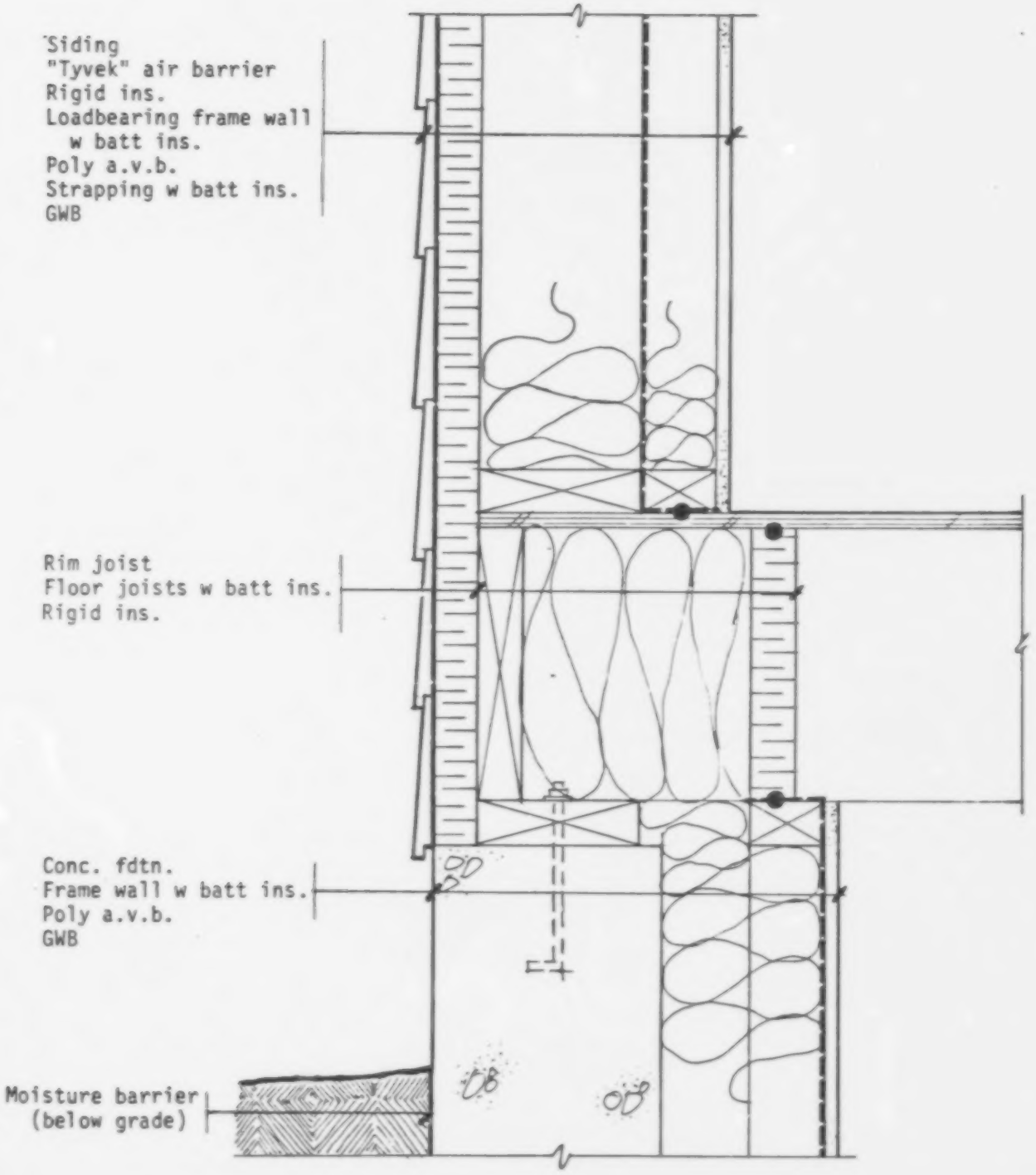
- exterior insulation is preferred to keep the foundation wall warmer and drier
- polyethylene should be installed on the inner surface of the foundation wall from agrade to footing to protect the batt insulation from moisture damage
- a flashing at the base of the siding is needed to direct water away from the foundation wall
- rigid insulation between the joists must be covered by drywall to satisfy fire codes
- base strapping should be nailed to the subfloor to prevent separation at this joint
- insulation should be installed in two layers to prevent vertical air channel behind studs at basement wall

Practical Application:

- extruded rigid insulation must be cut and fitted accurately in joist spaces and caulked to joists and subfloor
- subfloor should be glued or caulked to each joist
- sill plate should be pressure treated wood

AGW	BGW	RF	I		DATE	SCALE	DRWG#
21	22	--	01		12/84	1:5	27

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



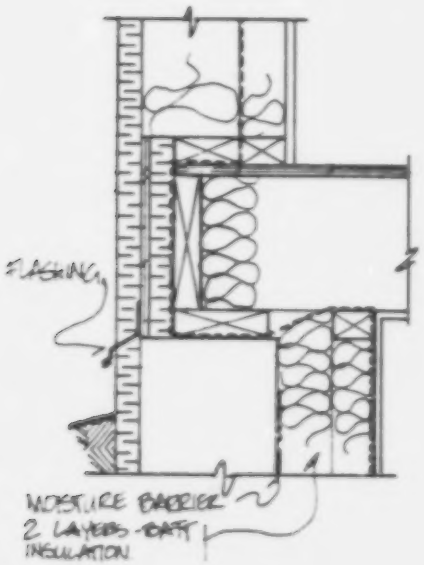
AGW	BGW	RF	I		DATE	SCALE	DRWG#
21	22	--	01		12/84	1:5	27

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD. to be used for documentary purposes only.

SILL DETAIL, SINGLE STUD WALL VARIATION WITH INTERIOR AND EXTERIOR BASEMENT INSULATION

This partially inset header detail incorporates a plywood nailer and extra piece of rigid insulation improving thermal performance at the header.

Technical Performance:



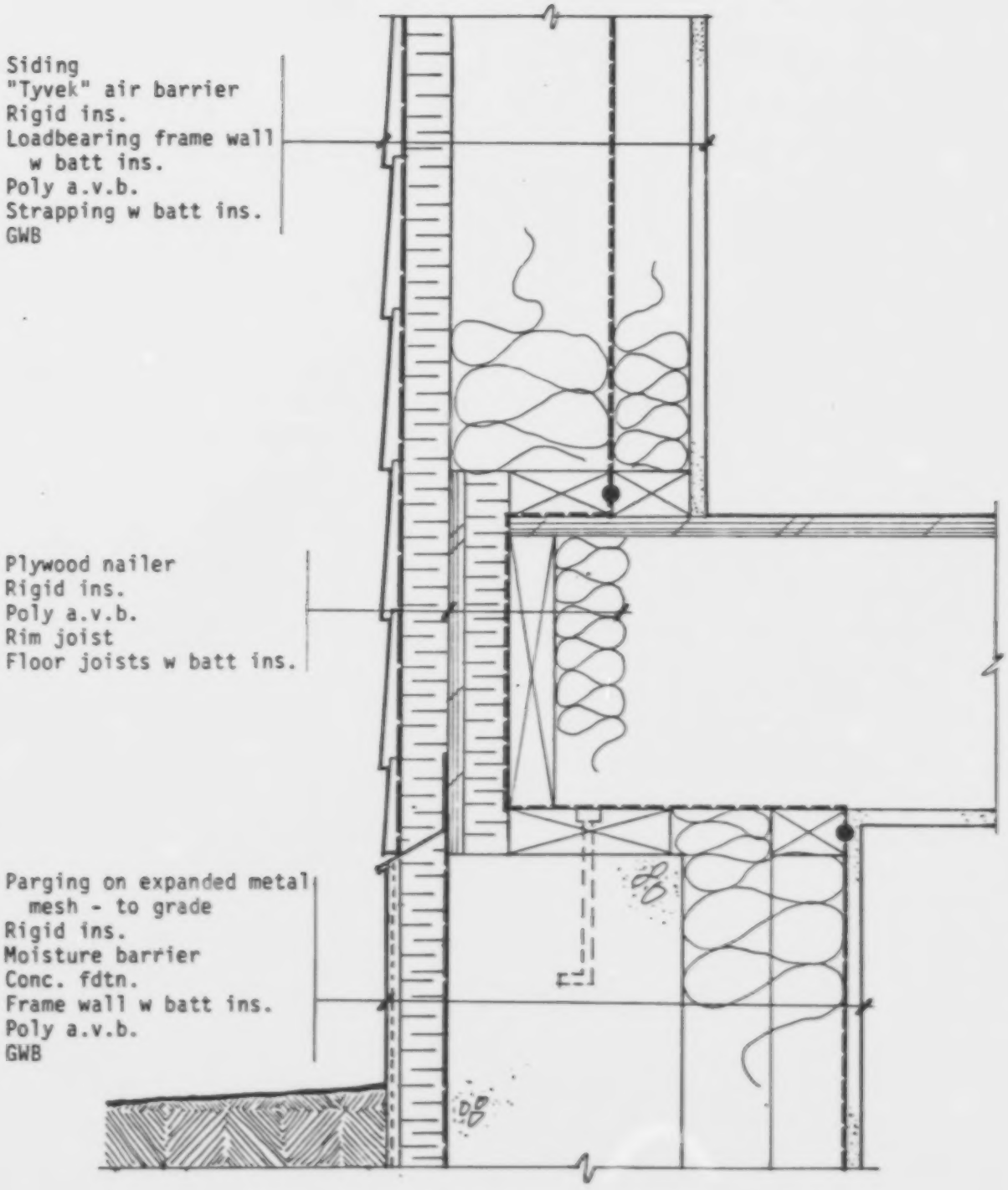
- exterior basement insulation is preferred to keep the foundation wall warmer and drier
- polyethylene should be installed on inner surface of foundation wall from grade to footing to protect this batt insulation from moisture damage
- a flashing at the base of the siding is needed to direct water away from parging
- basement insulation should be installed in two layers to prevent vertical air channels behind studs at basement wall
- the vapour barrier would be less subject to mechanical damage if laid underneath the sill plate
- sill plate should be pressure treated wood

Practical Application:

- a strip of polyethylene wide enough for header wrap has to be placed prior to laying joists
- the insulation between the joists should be not more than one third the total R value at the header

AGW	BGW	RF	I		DATE	SCALE	DRWG #
21	23	--	01		12/84	1:5	28

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD. to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
21	23	--	01		12/84	1:5	28

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

INTERMEDIATE FLOOR JUNCTION WITH PARTIALLY INSET HEADER, SINGLE STUD WALL VARIATION

The addition of a plywood nailer resolves siding attachment without the use of exterior strapping.

Technical Performance:

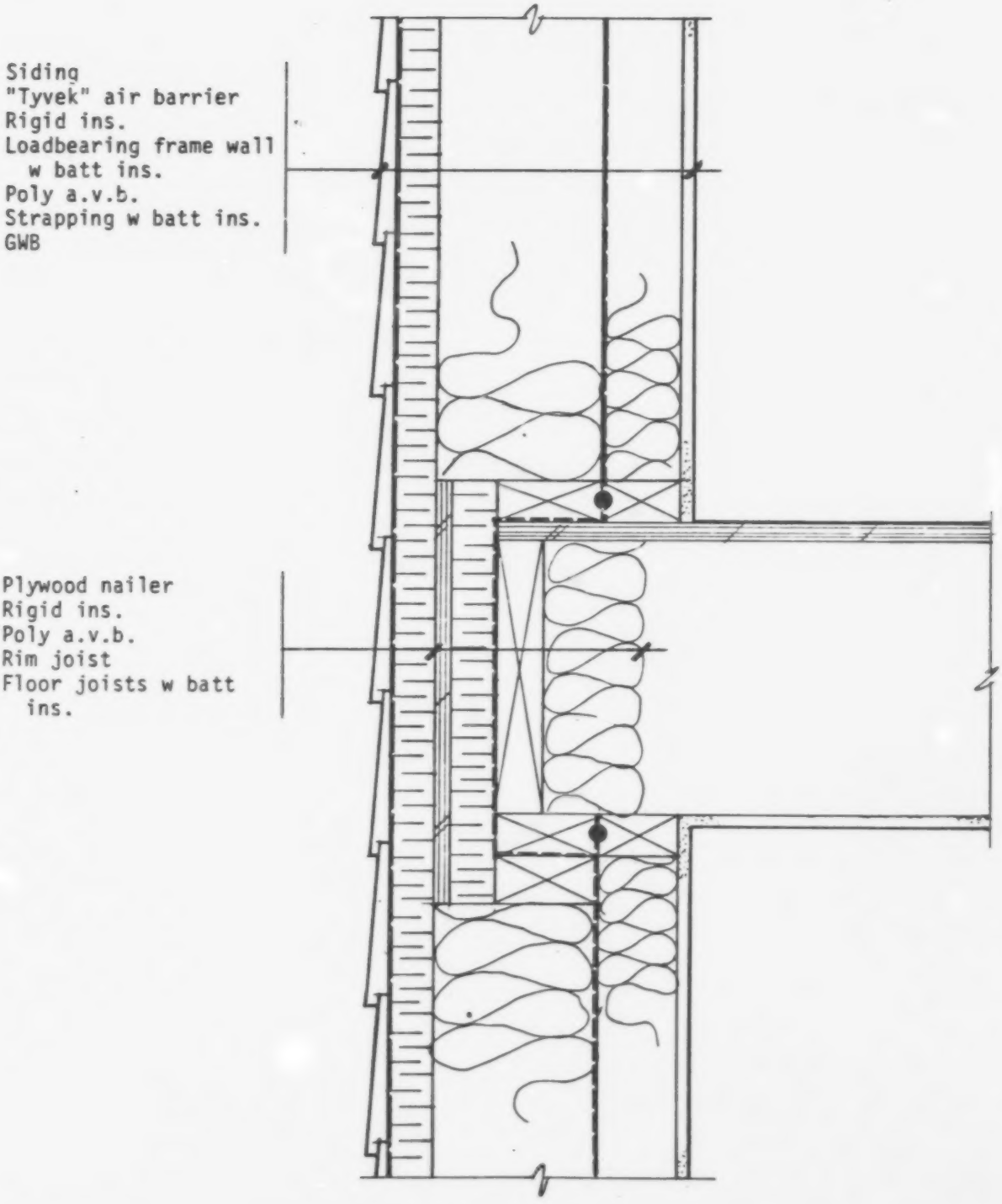
- airtightness, moisture protection and structural integrity are good
- only one-third of the total wall RSI can be placed on the warm side of the vapour barrier

Practical Application:

- close to conventional platform frame construction
- polyethylene must be installed around the header after subfloor is installed before the wall is erected
- the polyethylene can be damaged before the rigid insulation is put on
- 38 x 64 strapping provides support for baseboard and space for electrical wiring
- plywood nailer facilitates siding installation

AGW	BGW	RF	I		DATE	SCALE	DRWG#
21	--	--	06		12/84	1:5	29

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
21	--	--	06		12/84	1:5	29

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

INTERMEDIATE FLOOR JUNCTION WITH FULLY INSET HEADER, SINGLE STUD WALL VARIATION

The joists are supported by a built up ledger plate attached to the studs (fastening scheme unspecified) rather than joist hangers. The modified balloon frame allows easy installation of a continuous vapour barrier past the inset header and maintains level of insulation at header.

Technical Performance:

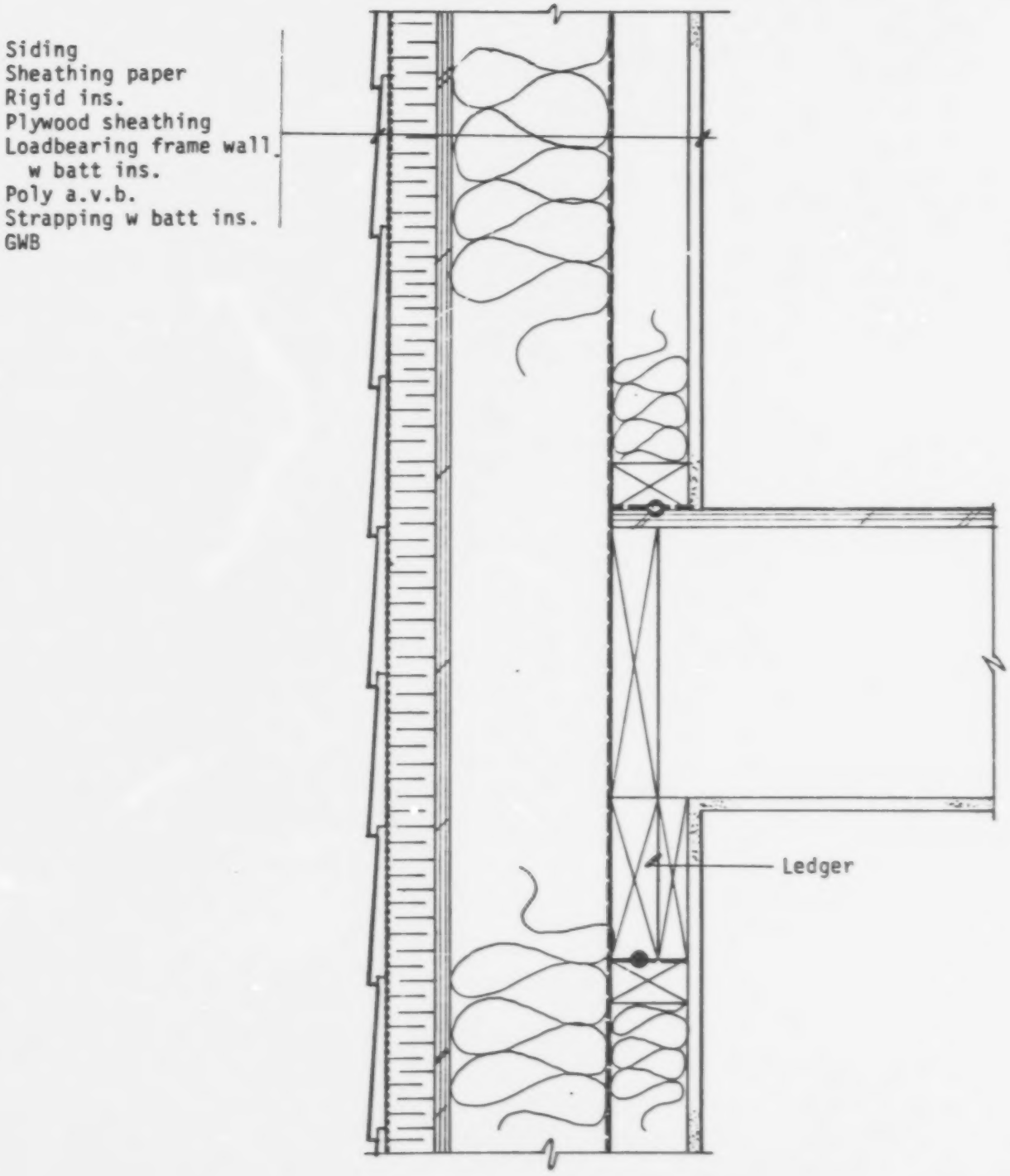
- adequate bearing must be provided for the floor joists and the ledger plate fastening must be specified
- detail as shown has good insulating and airtightness characteristics
- base strapping should be nailed through subfloor to joist to ensure the vapour barrier joint will not open due to differential shrinkage

Practical Application:

- polyethylene strip must be installed around header and under ledger before placement
- ledger must be inspected for adequate support
- 38 x 64 strapping provides support for baseboard and space for electrical installations
- plywood sheathing could be eliminated and replaced with diagonal bracing

AGW	BGW	RF	I		DATE	SCALE	DRWG#
21	--	--	06		12/84	1:5	30

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
21	--	--	06		12/84	1:5	30

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

EAVE DETAIL, RAISED HEEL TRUSS ON SINGLE STUD WALL VARIATION

The raised heel truss allows for adequate insulation levels at the eave. The strapped ceiling helps to reduce thermal bridging which can occur with this truss/wall type combination.

Technical Performance:

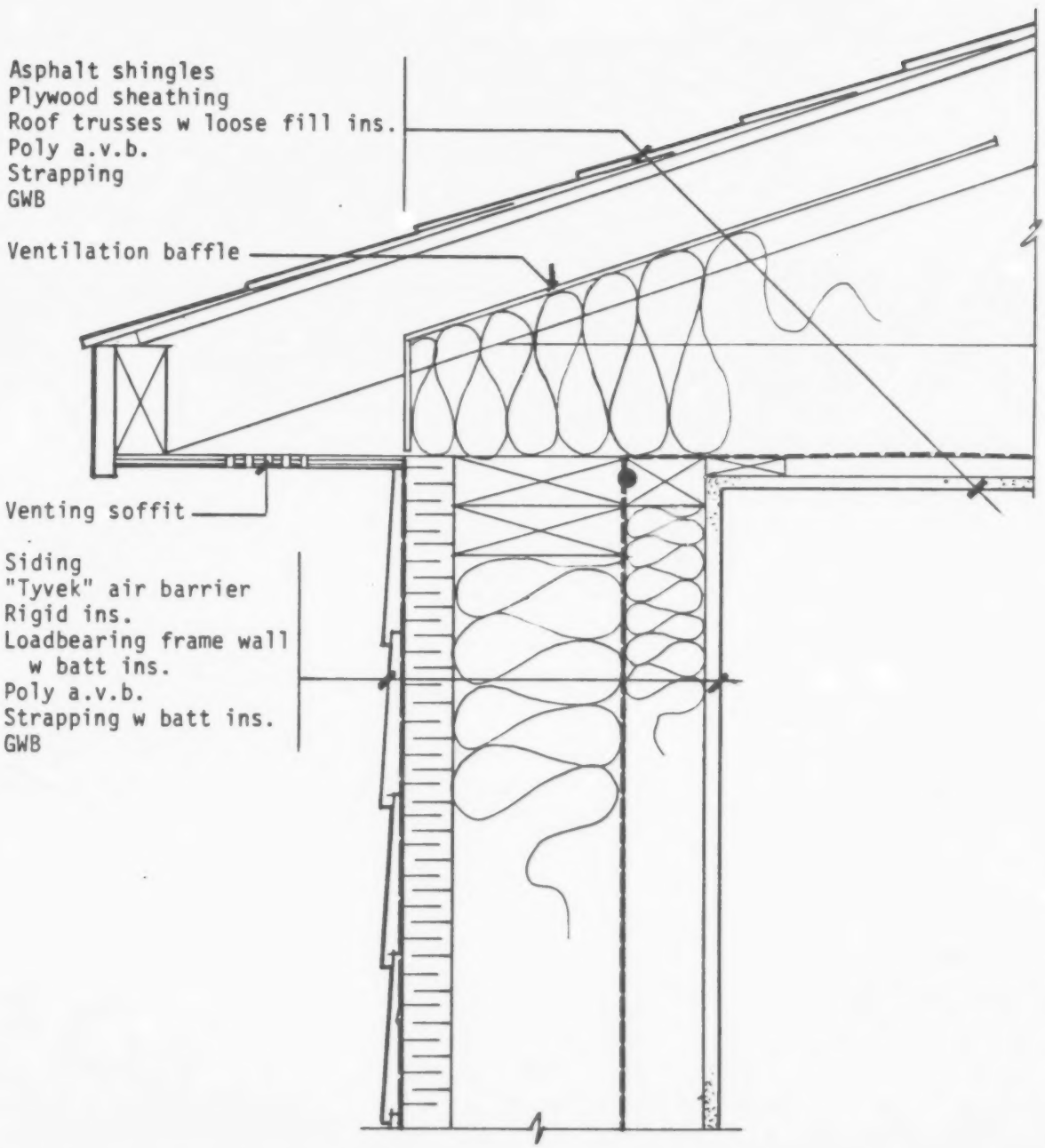
- a rigid insulation retainer must be used at the eave to prevent blow through leading to condensation and thermal degradation
- airtightness and structural integrity are good with the strapping compressing the vapour barrier at the top plate

Practical Application:

- single top plates can be employed if trusses are directly lined up over the studs
- ceiling strapping provides extra support for drywall and space for electrical wiring
- vapour barrier can be installed under weather protected conditions

AGW	BGW	RF	I		DATE	SCALE	DRWG#
21	--	31	10		12/84	1:5	31

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
21	--	31	10		12/84	1:5	31

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

BUILDING SYSTEM USING SINGLE STUD BALLOON FRAMING WITH EXTERIOR INSULATING SHEATHING AND INTERIOR STRAPPING ON CONCRETE FOUNDATION

The building section shown shows the following systems:

Concrete foundation with exterior insulation
Single frame wall with exterior insulating sheathing and interior 38 x 38 strapping
Raised heel standard truss

The above grade wall system is a modified balloon frame which permits the placement of full thickness of batt insulation at floor bands. Interior horizontal 38 x 38 mm strapping on the inner side of the sealed polyethylene air vapour barrier provides a wiring space inside the air-vapour barrier. The strapping space is not insulated but the foil-faced drywall is infrared reflective. The RSI value of the foil airspace combination has been omitted from the nominal RSI value but is included in the modified RSI calculation.

Nominal RSI: 4.4 Modified RSI: 4.66

System advantages:

- wiring does not penetrate the air-vapour barrier and drilling for wiring is reduced
- R values are maintained at floor bands
- single frame system may be erected and closed in rapidly; air sealing and strapping occurs under weather protected conditions

System disadvantages:

- balloon framing requires non-standard stud lengths
- let in diagonal bracing must be provided
- joist hangers or ledger strips are required to support intermediate floors
- strips of polyethylene must be installed behind floor headers

All AGW 22 drawings describe this wall type.

DRAWING #

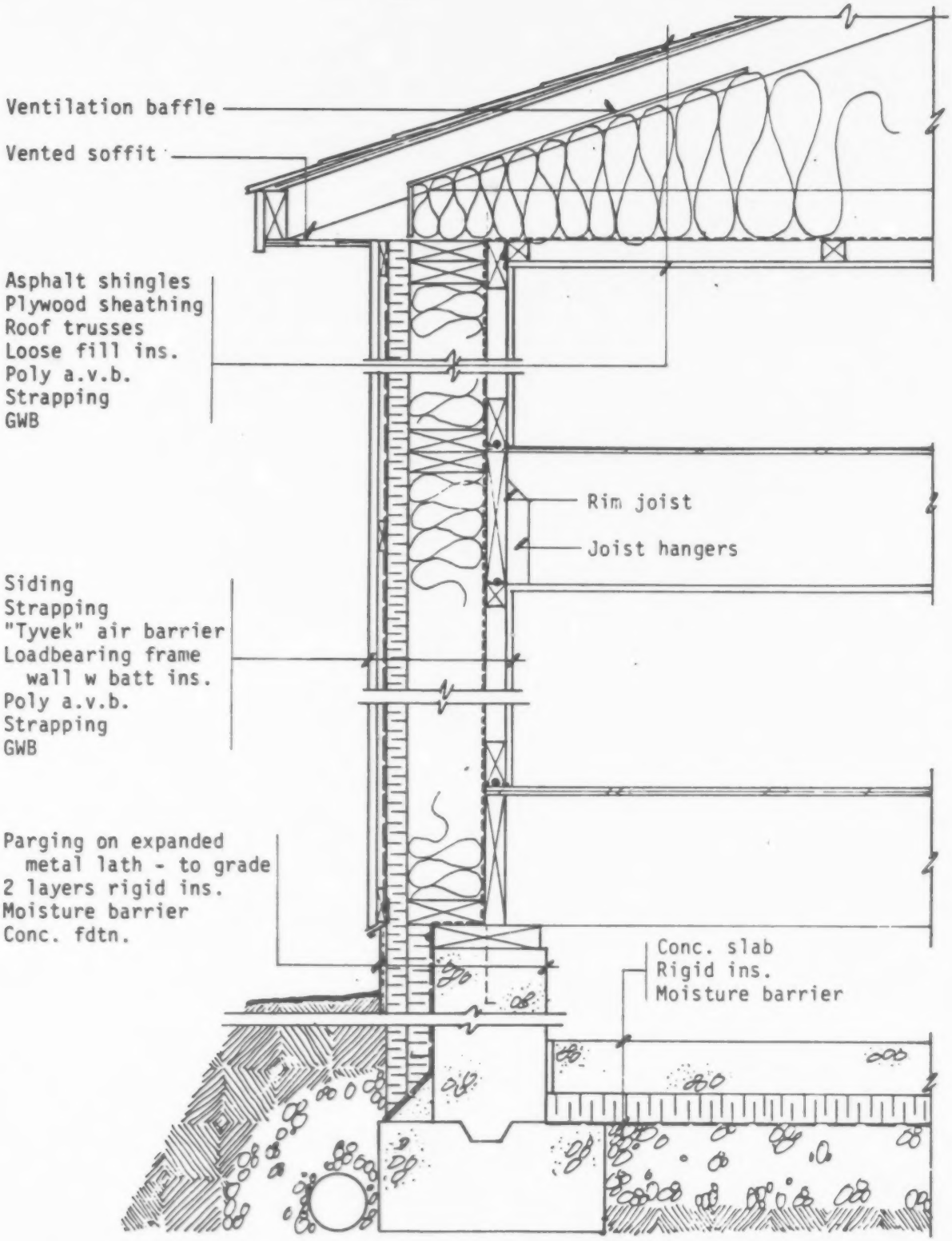
			33	PLAN OF WALL
				FOOTING
		35	34	SILL
		37	36	INTERMEDIATE FLOOR
			38	WINDOW
	90	39		EAVE

KEY DETAILS

Refer also to the sections on roofs, openings and penetrations for other applicable details

AGW	BGW	RF	I		DATE	SCALE	DRWG#
22	21	31			12/84	1:10	32

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD. to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
22	21	31			12/84	1:10	32

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

PLAN VIEW OF SINGLE STUD WALL WITH INSULATING SHEATHING AND INTERIOR 38 x 38 MM

This drawing illustrates three stud corner detailing and two methods of installing interior partitions with 38 mm strapping.

Technical Performance:

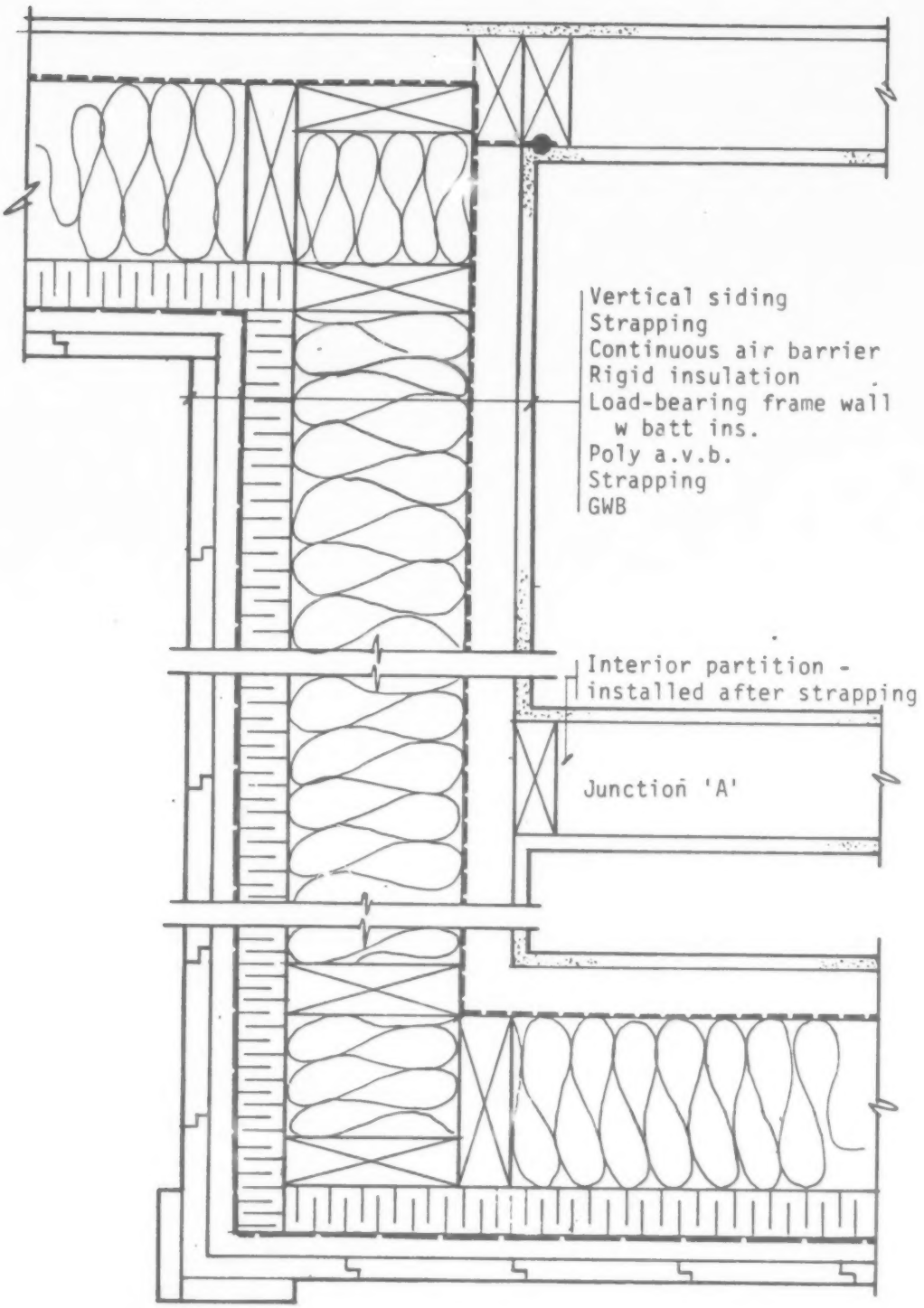
- an effective air barrier is provided
- the use of a secondary air barrier (Tyvek) reduces convective air movement in the batt insulation
- the optional use of cross strapping before siding provides improved moisture protection for the wall (rainscreen principle)
- foil faced drywall, facing a dead air space, increases the thermal resistance of the assembly. However a marginally greater R value would be obtained from batt insulation in the strapping space and standard drywall.

Practical Application:

- two stud corners and the use of drywall corner clips can reduce material costs (and minimize thermal bridging)
- alternatively, inside corners can be assembled as drawn
- 38 x 38 strapping is claimed to be easy to work with and is not materials intensive
- the use of foil faced drywall over a dead air space requires one less pass over the wall than the space system with insulation between the strapping
- the interior partition junction 'A' in which the partition is set back 38 mm from the exterior bearing wall uses less material and does not require additional joints in the air-vapour barrier

AGW	BGW	RF	I		DATE	SCALE	DRWG#
22	--	--	07		12/84	1:5	33

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG #
22	--	--	07		12/84	1:5	33

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

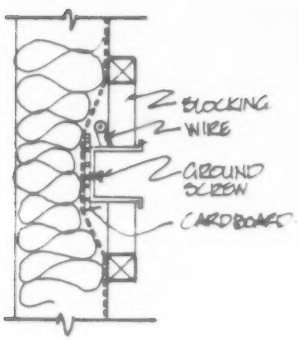
SILL DETAIL, SINGLE FRAME VARIATION WITH FULLY INSET HEADER

Header is fully inset with respect to frame wall. Detail allows for good airtightness and insulation levels. The exterior horizontal strapping provides a desirable air space between siding and sheathing. The interior strapping is used to compress and support the caulked joints of the air-vapour barrier and to provide a wiring chase.

Technical Performance:

- foundation wall dampproofing can double as air barrier if joined to polyethylene above

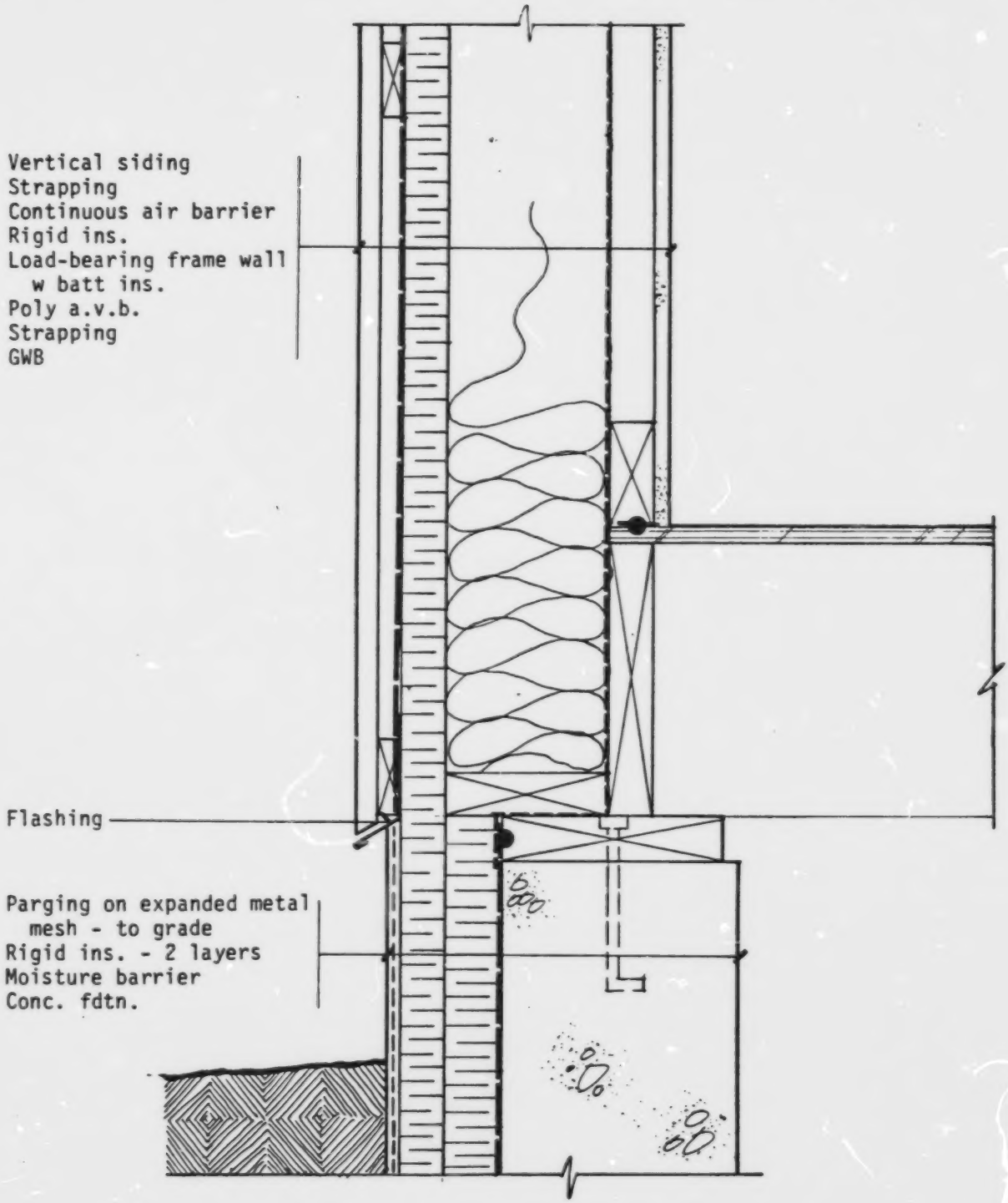
Practical Application:



- polyethylene strip must be draped over header prior to erection of wall. This strip is subject to mechanical damage unless protected
- flashing at base of siding must direct water away from parging
- standard electrical boxes may puncture the air-vapour barrier unless cardboard or other protection is placed behind the box
- sill plate anchor bolt should be well countersunk to prevent damage to polyethylene

AGW	BGW	RF	I		DATE	SCALE	DRWG#
22	21	--	01		12/84	1:5	34

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
22	21	--	01		12/84	1:5	34

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

SILL DETAIL, SINGLE FRAME VARIATION WITH BRICK VENEER

This detail utilizes an insulated concrete block (Sparfil™) as a thermal break at the sill. It is suitable for any single frame wall on masonry foundation with exterior insulation where brick veneer must be employed. A plywood header increases the bearing available for the floor joists.

Technical Performance:

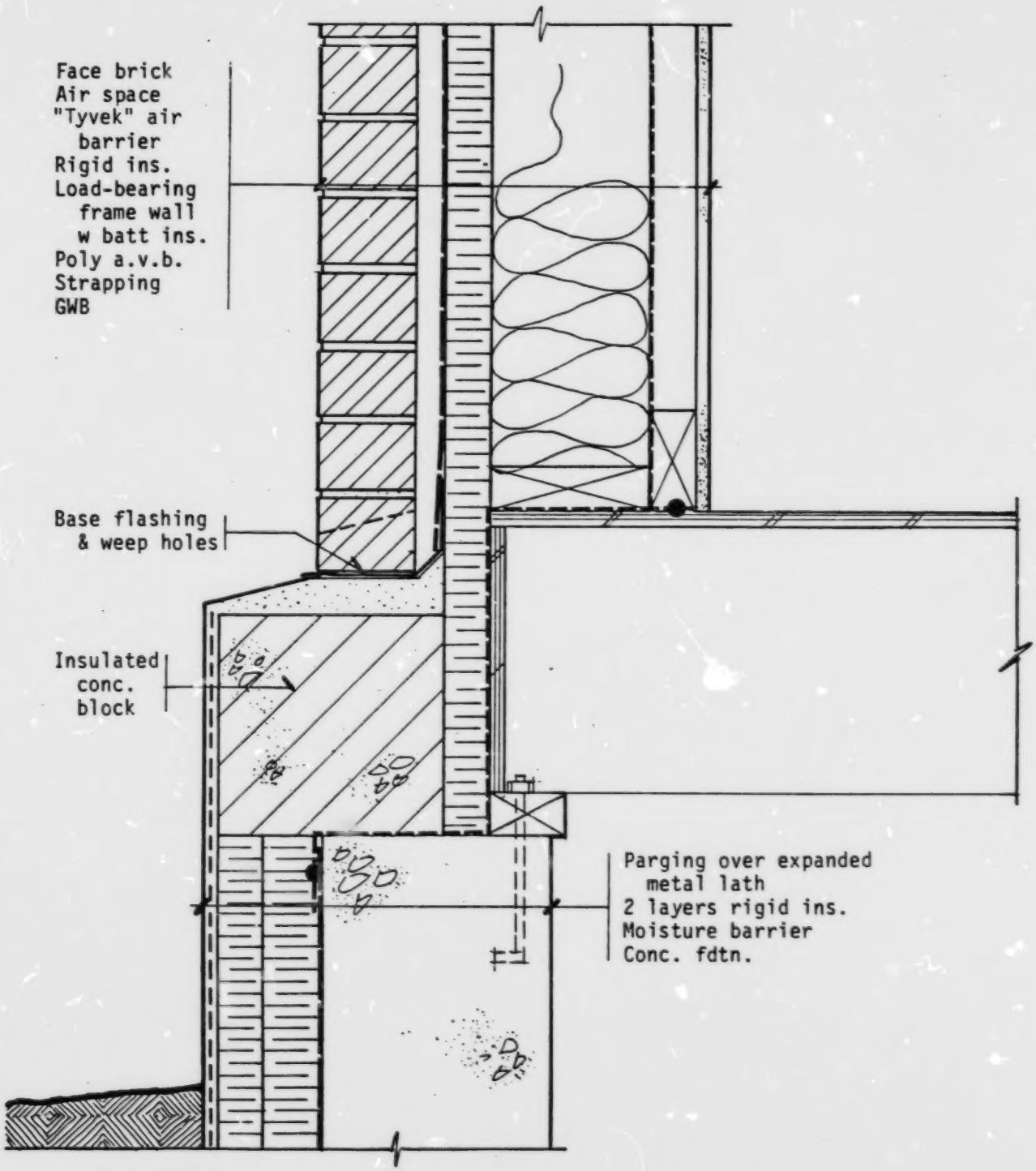
- joist bearing is marginally adequate as shown. A thicker foundation wall would improve the bearing and eliminate the need for a plywood header
- batt insulation between the joists (maximum 1/3 of total R value of assembly) would improve thermal performance
- foundation wall dampproofing can double as air barrier if joined to polyethylene above
- flashing at base of brick veneer should extend well up the wall and out beyond the insulated block

Practical Application:

- polyethylene strip at header must be installed before rigid insulation

AGW	BGW	RF	I		DATE	SCALE	DRWG#
22	21	--	01		12/84	1:5	35

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
22	21	--	01		12/84	1:5	35

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

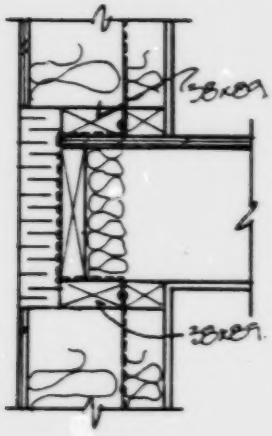
INTERMEDIATE FLOOR JUNCTION WITH PARTIALLY INSET HEADER, SINGLE STUD WALL VARIATION

Single stud wall with interior strapping shows excessive stud overhang, minimum joist bearing and thermal bridging at plates.

Technical Performance:

- thermal bridging occurs at the top and bottom plates. This could be reduced by using 38 x 89 plates
- adequate bearing must be provided for the floor joists

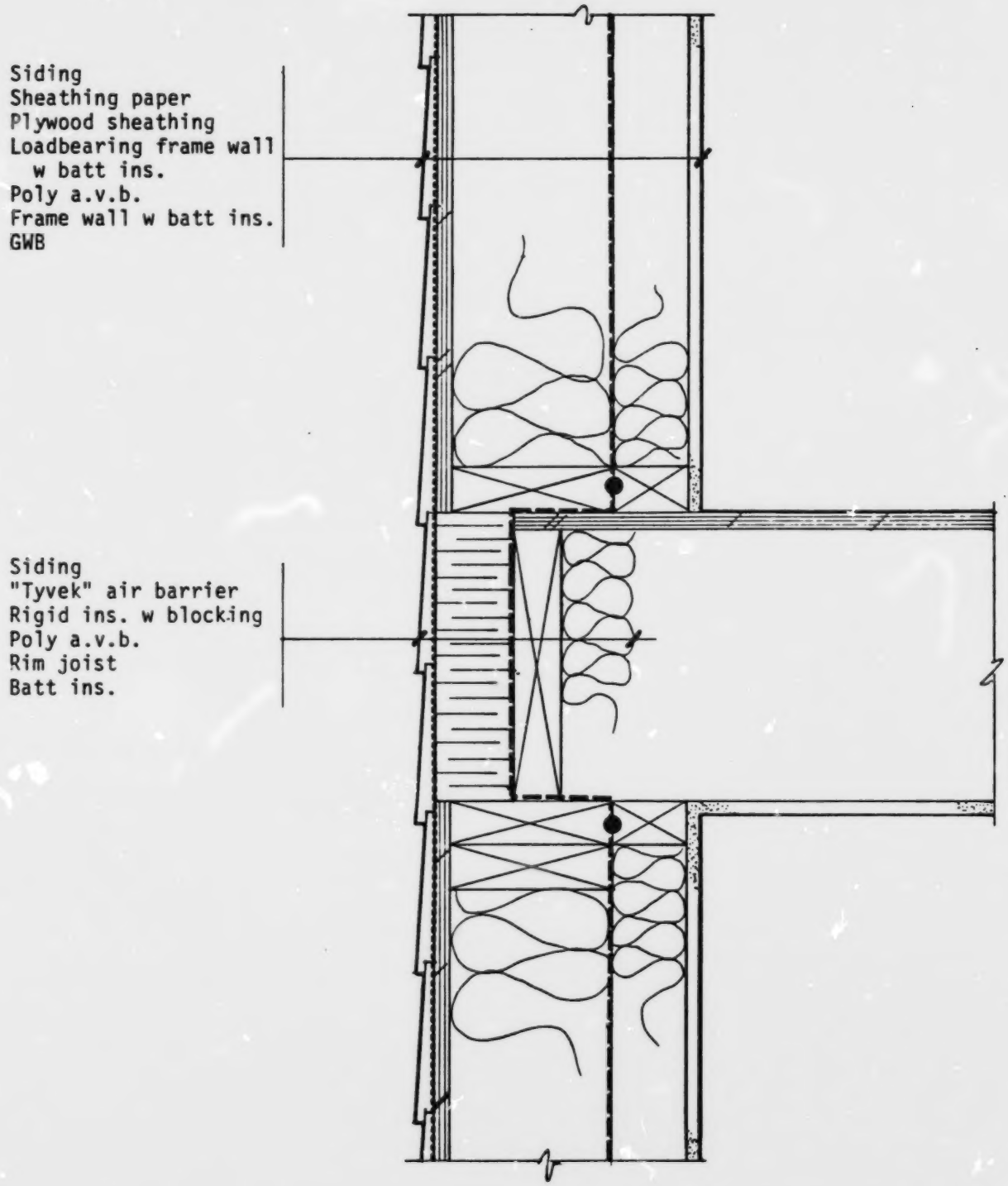
Practical Application:



- a strip of polyethylene must be wrapped around the header after the subfloor has been installed
- the vapour barrier at the header band can be damaged due to exposure to the weather. U.V. stabilized polyethylene is recommended
- strapping space provides for electrical services
- vertical blocking at even centres attached to the header band is installed before rigid insulation as nailers for the siding

AGW	BGW	RF	I		DATE	SCALE	DRWG#
23	--	--	06		12/84	1:5	45

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
23	--	--	06		12/84	1:5	45

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

INSULATED WOOD FLOOR OVER UNHEATED CRAWLSPACE WITH SINGLE STUD WALL VARIATION

In this detail a thermal break has been included behind the base strapping and between the header and exterior sheathing.

Technical Performance:

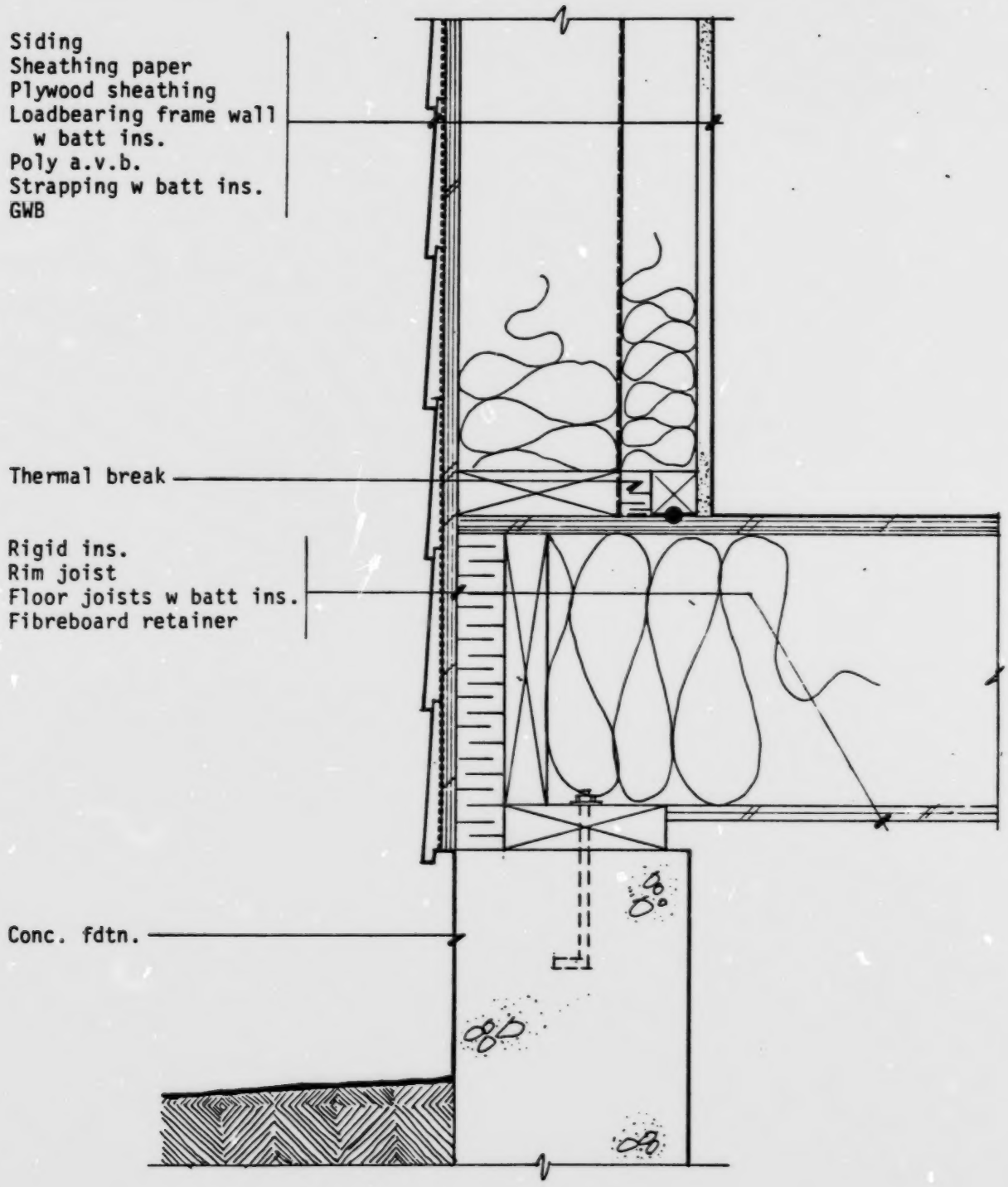
- thermal performance would be further is improved over by the use of 38 x 89 bottom plate and the extension of the rigid insulation to the base of the studs
- a moisture barrier is required to cover exposed subsoil in the crawlspace
- base strapping should be nailed to the subfloor to prevent separation at this point
- sill plate should be pressure treated wood
- in cold climates a layer of rigid insulation on the exterior of the foundation wall may be required to prevent adfreezing. Granular backfill and polyethylene slip surface may also be required in extreme conditions

Practical Application:

- rigid insulation thermal break is placed behind 38 mm x 38 mm batten strapping and fastened to the bottom plate
- joints in subfloor must be glued or caulked

AGW	BGW	RF	I		DATE	SCALE	DRWG #
23	20	--	01		12/84	1:5	44

Drawn for CMHC under File no. 8350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.



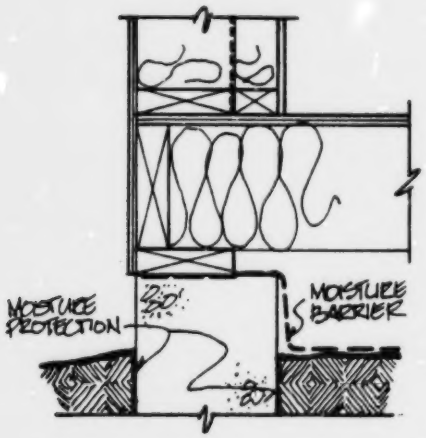
AGW	BGW	RF	I		DATE	SCALE	DRWG#
23	20	--	01		12/84	1:5	44

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

INSULATED WOOD FLOOR OVER UNHEATED CRAWLSPACE WITH SINGLE STUD WALL VARIATION

This detail shows a well insulated floor over an unheated crawlspace with a single stud wall resting on a concrete foundation.

Technical Performance:



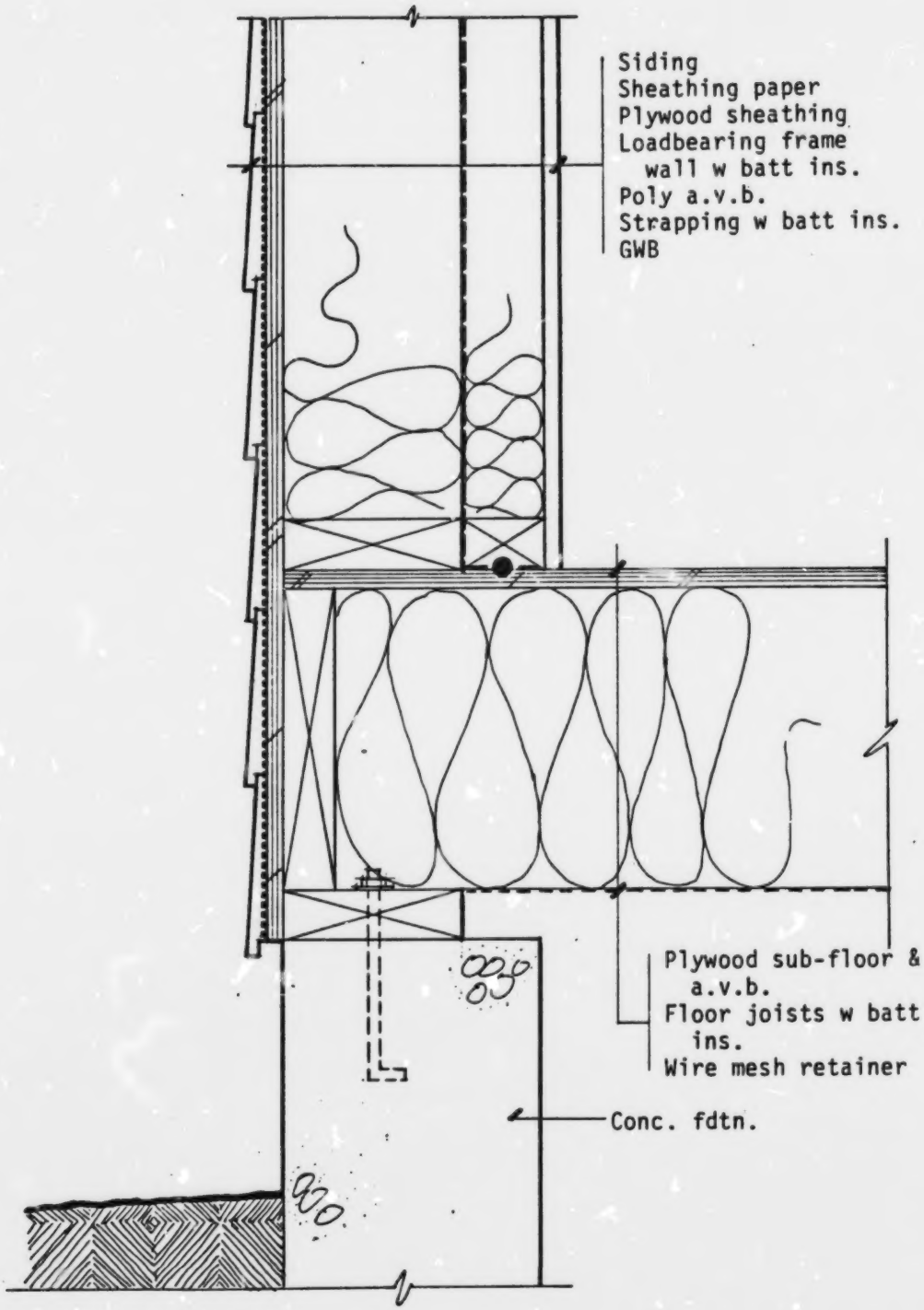
- a thermal bridge exists at the bottom plate. It is possible to use a 38 x 89 bottom plate and ensure that insulation is fitted between the plate and the exterior sheathing
- in some climates and soil conditions adfreezing may occur on both sides of the foundation in cold climates. Well draining backfill, insulation or a polyethylene sheet can be applied to both below grade sides to prevent this
- the base strapping should be nailed to the subfloor to prevent separation at this joint
- sill plate should be pressure treated wood

Practical Application:

- foundation wall should be back filled with well draining material
- strapping space allows for electrical services without breaking the vapour barrier
- a polyethylene moisture barrier should be draped over the foundation wall and must be laid on the crawlspace floor

AGW	BGW	RF	I		DATE	SCALE	DRWG#
22	20	--	01		12/84	1:5	43

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



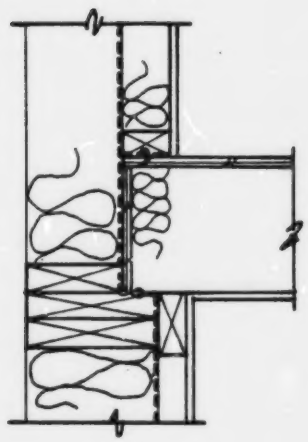
AGW	BGW	RF	I		DATE	SCALE	DRWG#
22	20	--	01		12/84	1:5	43

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

SILL DETAIL, SINGLE FRAME VARIATION WITH PRESERVED WOOD FOUNDATION

This single frame wall with interior strapping shows an inset header on a preserved wood foundation. Reasonable levels of insulation are maintained at the header though thermal bridging is evident at the top plates..

Technical Performance:



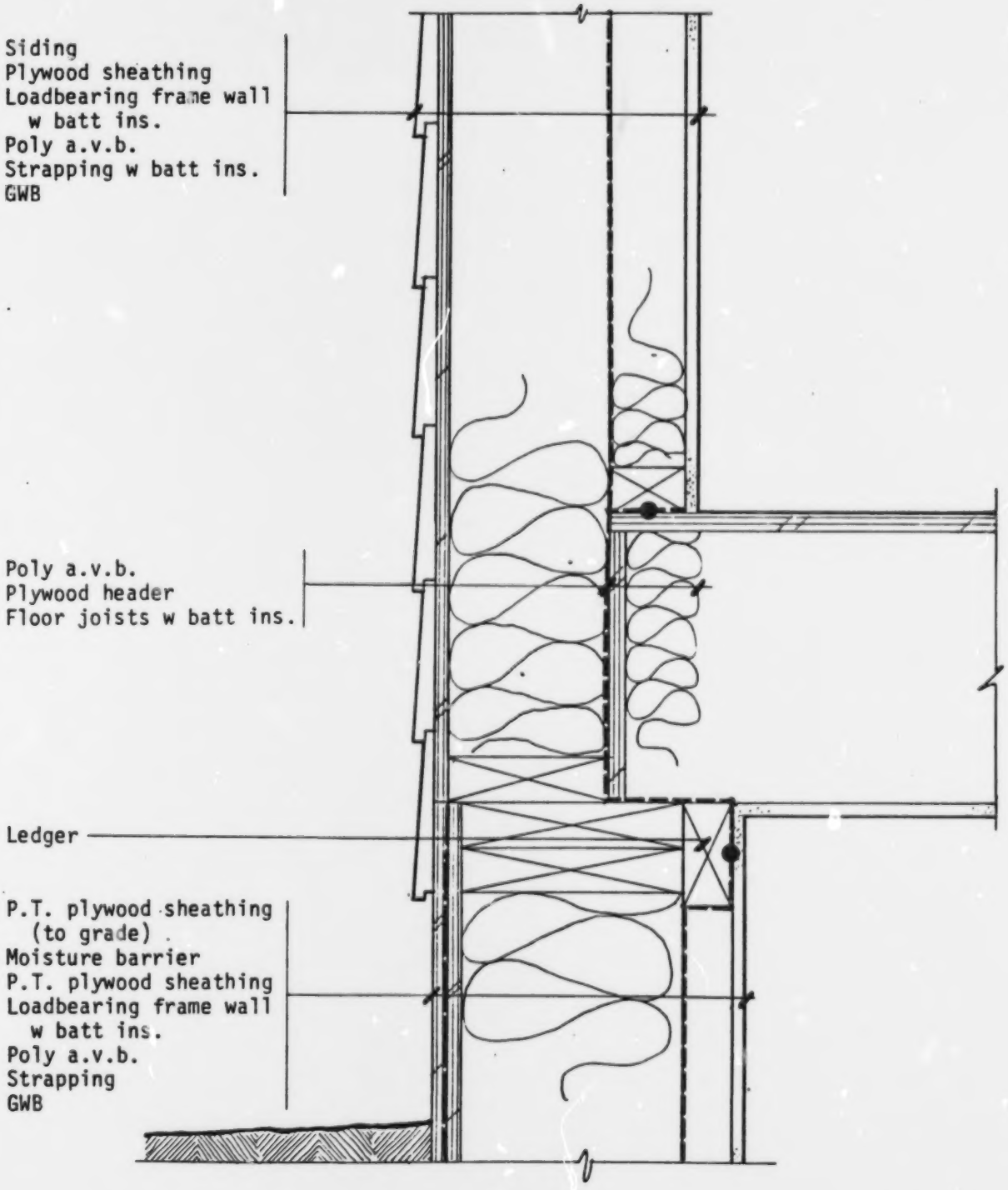
- thermal bridging at the top plate of the foundation wall
- steel strap is required at the joists for lateral support
- use of plywood header permits adequate bearing of floor joists on top plates removing the need for the ledger as shown except as part of the strapping
- the vapour barrier should be placed behind the top strapping
- base strapping should be nailed to the subfloor to prevent separation at this joint

Practical Application:

- polyethylene strip must be wrapped around header after subfloor is in place
- care must be used when installing the header so that the vapour barrier is not damaged
- exterior sheathing should not be sealed to allow moisture to escape
- strapping space allows electrical services to be installed inside the vapour barrier

AGW	BGW	RF	I		DATE	SCALE	DRWG#
23	29	--	01		12/84	1:5	42

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG #
23	29	--	01		12/84	1:5	42

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

GABLE DETAIL, SINGLE FRAME WRAP AND STRAP WALL

This detail allows for both high insulation levels and potentially good airtightness.

Technical Performance:

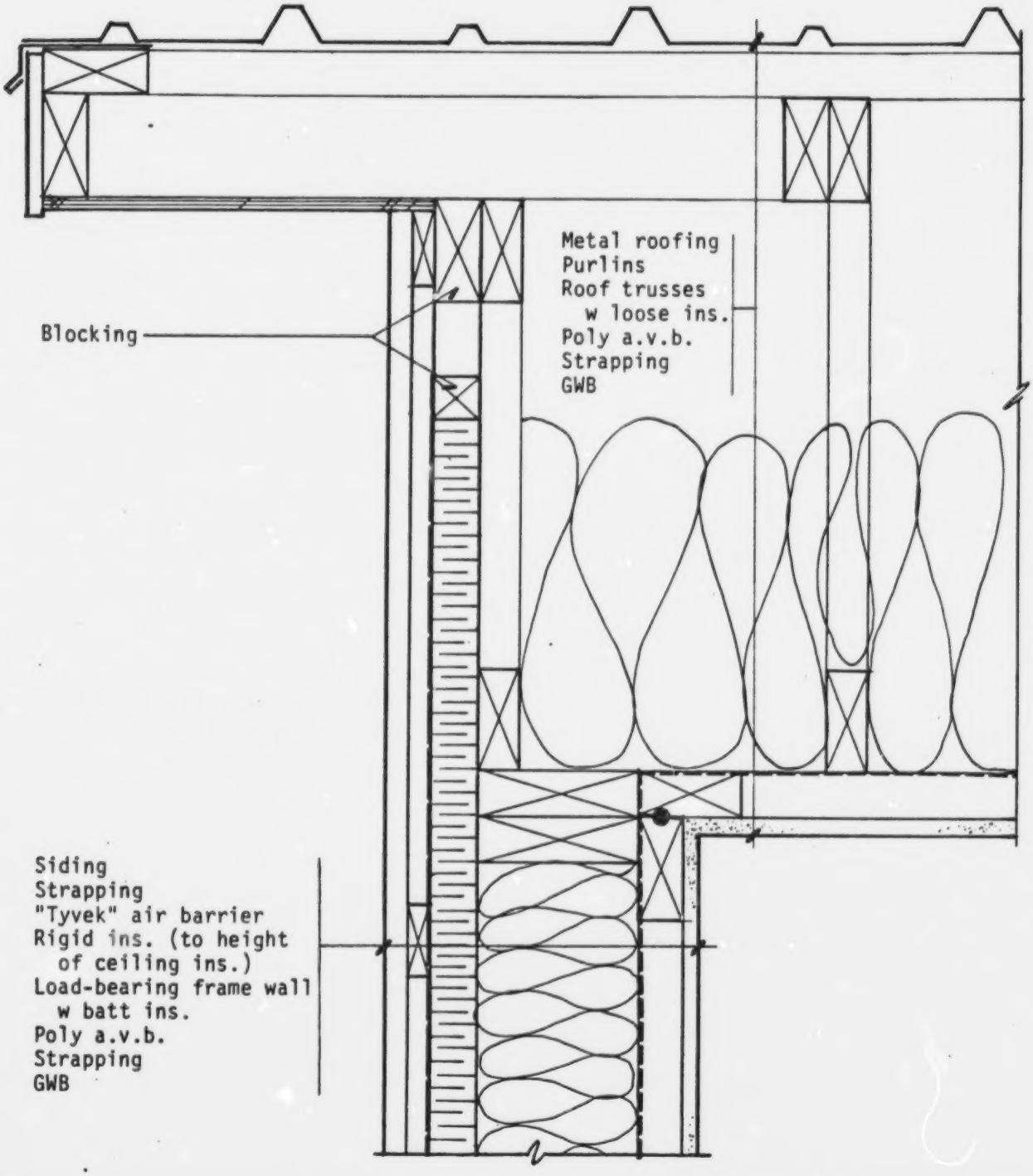
- the insulating sheathing and exterior air barrier (Tyvek™) must extend at least to the top of the attic insulation as shown to prevent 'blow through'.

Practical Application:

- ceiling strapping can be omitted, and the drywall supported on drywall clips, if there is no wiring in the ceiling. In this case the drywall must be thick enough to avoid sagging.
- blocking at top of insulating sheathing could be eliminated and air barrier extended to soffit

AGW	BGW	RF	I		DATE	SCALE	DRWG#
22	--	31	11		12/84	1:5	41

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
22	--	31	11		12/84	1:5	41

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

EAVE DETAIL, CATHEDRAL CEILING RAFTERS WITH PURLINS ON SINGLE FRAME WALL VARIATION

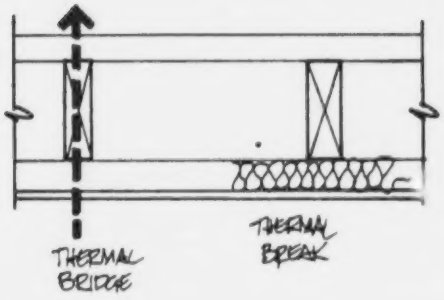
Detail permits adequate insulation and ventilation of the roof cavity.

Technical Performance:

- some thermal bridging through the rafters will occur. This could be prevented by placing insulation in the strapping cavity

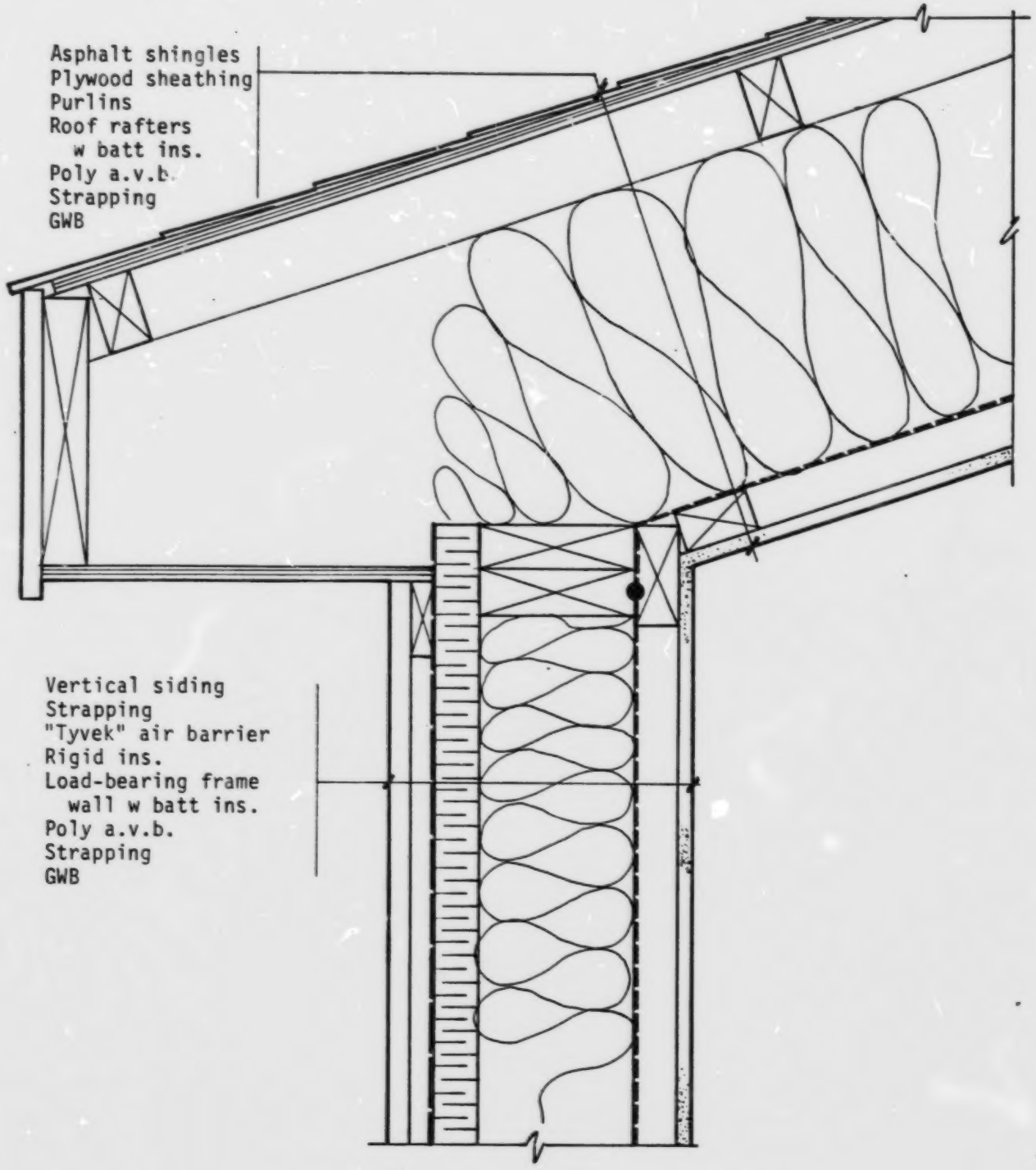
Practical Application:

- note the ventilation space between the purlins. This requires continuous gable end vents rather than soffit vents



AGW	BGW	RF	I		DATE	SCALE	DRWG #
22	--	38	10		12/84	1:5	40

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
22	--	38	10		12/84	1:5	40

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

EAVE DETAIL, RAISED HEEL TRUSS
ON SINGLE STUD WRAP AND STRAP WALL VARIATION

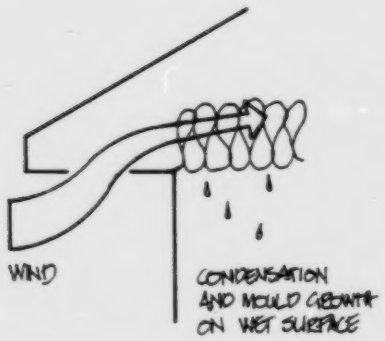
The steep pitch of this roof permits more insulation at the eave than lower pitches. The detail would allow for both high insulation levels and potentially good airtightness if a solid insulation retainer rather than batt insulation was employed.

Technical Performance:

- batt insulation retainer permits "blow through" and potential for condensation damage

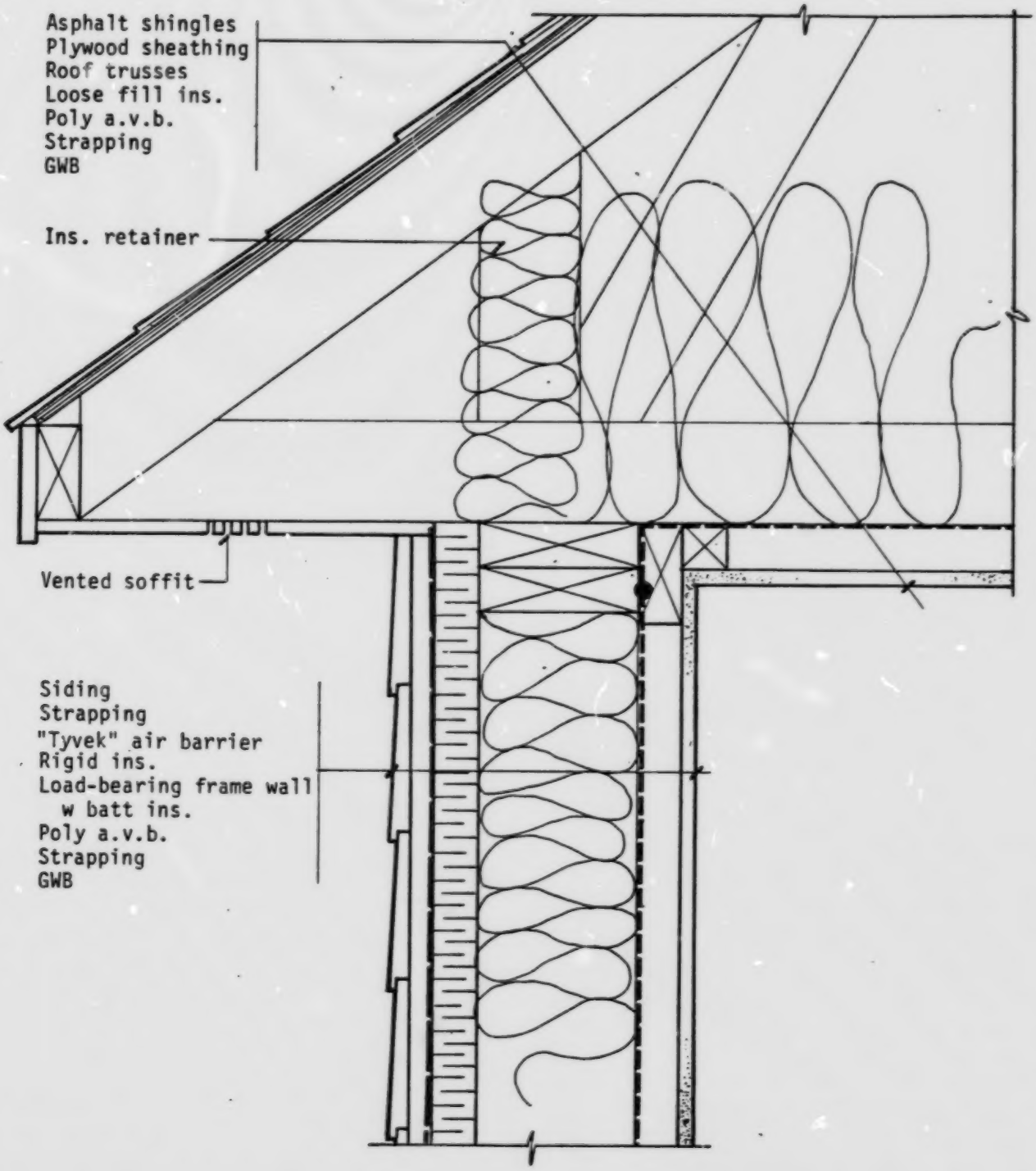
Practical Application:

- single top plates can be employed if trusses are directly lined up over studs
- ceiling strapping can be omitted and the drywall supported on drywall clips if there is no wiring in the ceiling. In this case the drywall must be thick enough to resist sagging



AGW	BGW	RF	I		DATE	SCALE	DRWG
22	--	31	10		12/84	1:5	39

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
22	--	31	10		12/84	1:5	39

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

WINDOW DETAIL, SINGLE STUD WALL WRAP & STRAP VARIATION

This window technique provides adequate backing for finishes and potentially good airtightness characteristics but exhibits thermal bridging and uses excessive framing material.

Technical Performance:

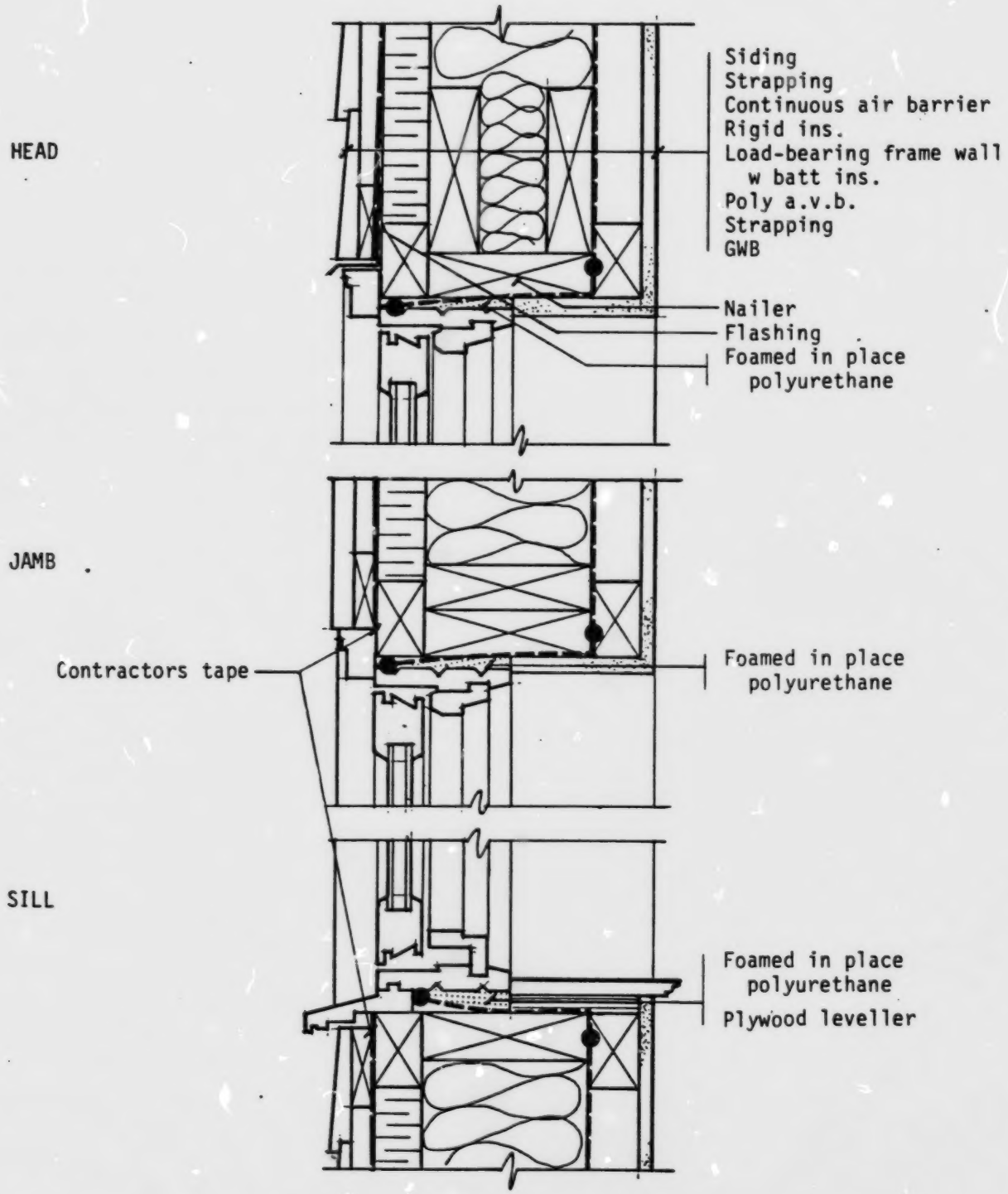
- a thermal break is required to prevent thermal bridging at the rough stud opening

Practical Application:

- elimination of perimeter blocking would reduce materials, labour and thermal bridging
- polyethylene window wrap is installed on outside of window frame prior to window placement
- foamed in place polyurethane or closed cell polyethylene rope may be used to fill space between rough opening and window

AGW	BGW	RF	I		DATE	SCALE	DRWG#
22	--	--	22		12/84	1:5	38

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.



AGW	BGW	BF	I		DATE	SCALE	DRWG#
22	--	--	22		12/84	1:5	38

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

INTERMEDIATE FLOOR JUNCTION, MODIFIED BALLOON FRAME

Single stud, wrap and strap variation. Fastening information for previous drawing. This was the only drawing submitted which provided detailed fastening information for conditions where fasteners are not prescribed by code. The type, size and spacing of fasteners should be specified.

Technical Performance:

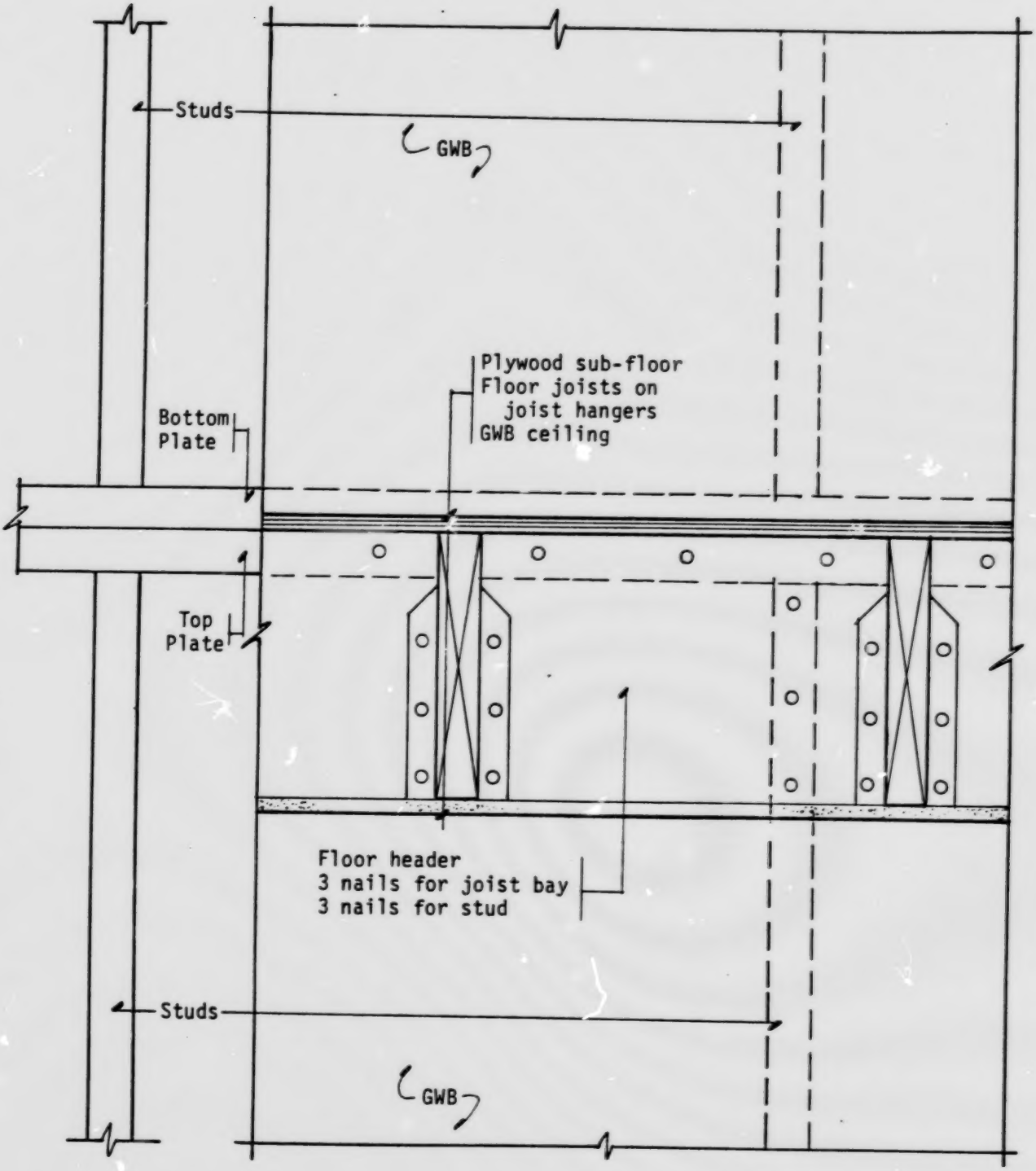
- lengths of nail should be specified.

Practical Application:

- if joist hangers are prenailed to header, they must be offset from studs

AGW	BGW	RF	I		DATE	SCALE	DRWG#
22	--	--	06		12/84	1:5	37

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
22	--	--	06		12/84	1:5	37

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

INTERMEDIATE FLOOR JUNCTION, MODIFIED BALLOON FRAME WITH INTERIOR STRAPPING

Single stud wrap and strap variation showing the use of joist hangers with modified balloon framing and interior 38 x 38 strapping. Fastening information is provided (next page).

Technical Performance:

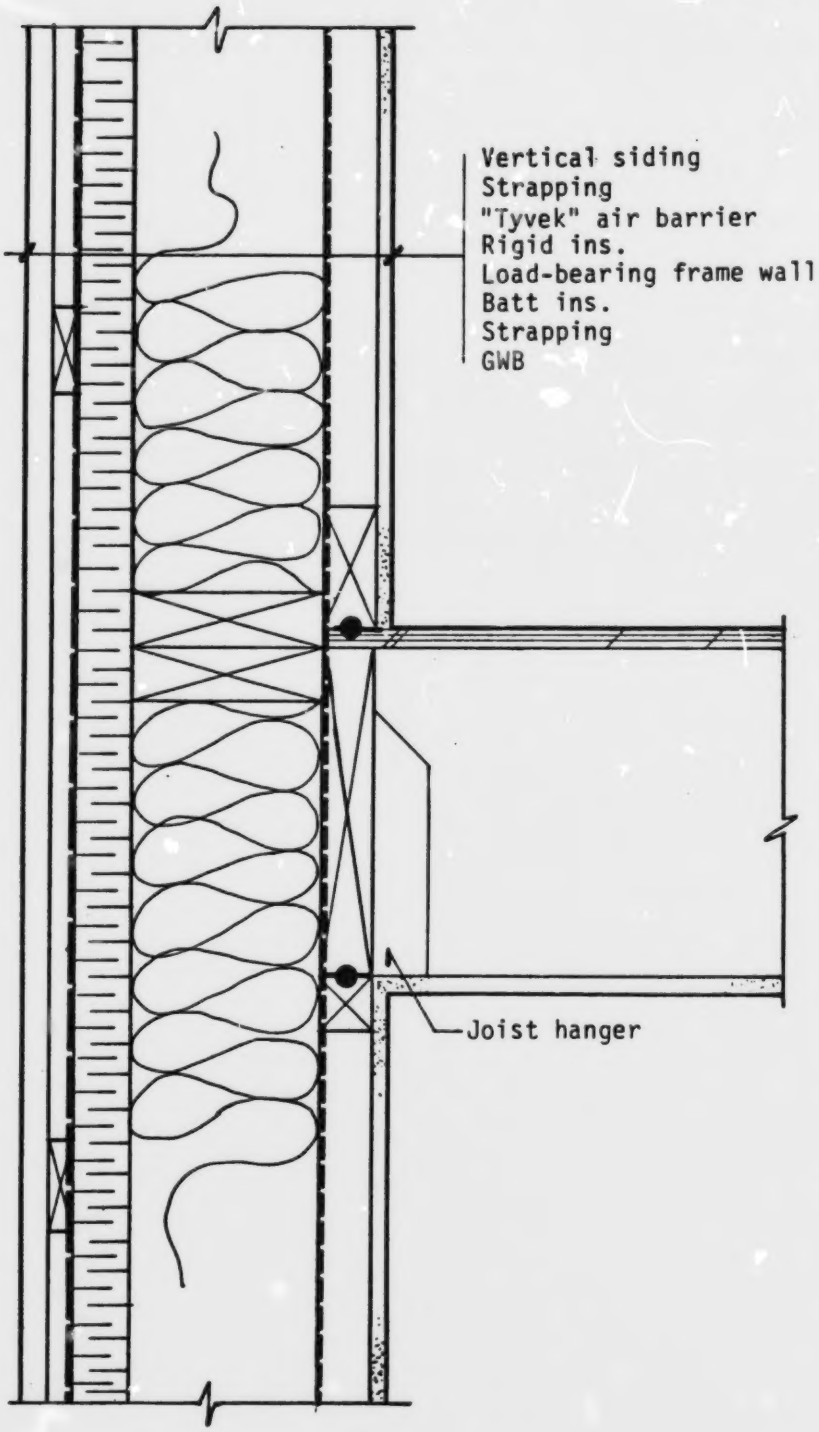
- thermal resistance at wall plates is low
- airtightness characteristics appear good
- use of exterior strapping provides desirable airspace behind siding
- structural performance is dependent on fasteners specified

Practical Application:

- polyethylene strip must be installed prior to header placement
- joist hangers may be prenailed to header
- assembly must be inspected for adequate fastening
- 38 x 89 strapping at base of wall provides baseboard support

AGW	BGW	RF	I		DATE	SCALE	DRWG#
22	--	--	06		12/84	1:5	36

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



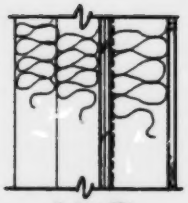
AGW	BGW	RF	I		DATE	SCALE	DRWG#
22	--	--	06		12/84	1:5	36

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

THICK WALL - DOUBLE FRAME SYSTEMS

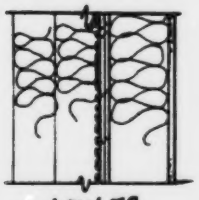
Wall systems in which the thickness can be increased at will are referred to as thick wall systems. For consistency, all thick wall systems in this document have been drawn at 300 mm with a nominal R value of R 7. However nominal R values may range from about R 5 to R 10. Double frame systems consist of two parallel stud walls spaced apart to create the desired cavity. Either the inner or the outer wall may be loadbearing.

The following section documents four double frame wall variations:



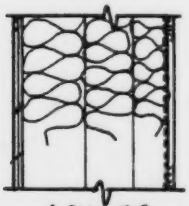
AGW 51

AGW 51 drawings show the system developed in Saskatchewan in which the interior wall is loadbearing and inner and outer walls are prefabricated together on the platform and erected as a unit. The air-vapour barrier is recessed in the wall.



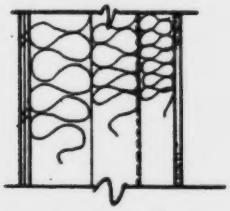
AGW 52

AGW 52 drawings show a variation of AGW 51 in which the walls are placed separately.



AGW 53

AGW 53 drawings shown a conventional exterior bearing wall with a non-bearing inner wall and surface applied air-vapour barrier.



AGW 54

AGW 54 drawings show a variation of AGW 53 with a recessed air-vapour barrier.

Full building sections are drawn for systems AGW 51 and AGW 53.

Observations:

1. The air-vapour barrier must remain above dew point temperatures which means, normally that at least two thirds of the total R value of the wall must be placed on the outside of the air-vapour barrier.

2. The foundation system selected must be compatible with the above grade wall. There is much less flexibility with regards to choice of foundation with double frame systems than with single frame systems.

3. If the air-vapour barrier is surface mounted on the interior wall proper trades supervision is essential to ensure that it is properly installed and not damaged. If the air-vapour barrier is recessed within the wall framing crews must be instructed how to install it.

THICK WALL - DOUBLE FRAME SYSTEMS (cont'd)

4. Before deciding on a thick wall system incremental costs should be compared to those of a single frame system with a high efficiency heat recovery ventilation system (see Table 1).

BUILDING SECTION WITH DOUBLE FRAME WALL, INTERIOR FRAME LOAD BEARING ON PRESERVED WOOD FOUNDATION

The building section shown illustrates the following combination of systems:

Double frame preserved wood foundation
Double frame above grade wall, interior frame loadbearing
Raised heel standard truss

This combination of systems provides high R values and good airtightness.

The wall system was developed in Saskatchewan. Inner and outer walls are framed and erected together as a unit.

Nominal RSI: 7.0 Modified RSI: 6 44

System Advantages:

- system has excellent thermal characteristics
- services are located inside the avb
- minimum coordination between trades is required
- system can be designed to use standard length stock

System Disadvantages:

- framing is more complex than conventional and requires specially trained crews
- mechanical assistance may be required to erect walls
- complex envelope configurations are difficult to handle
- system is materials and labour intensive compared to conventional

All AGW 51 drawings describe this wall type.

DRAWING #

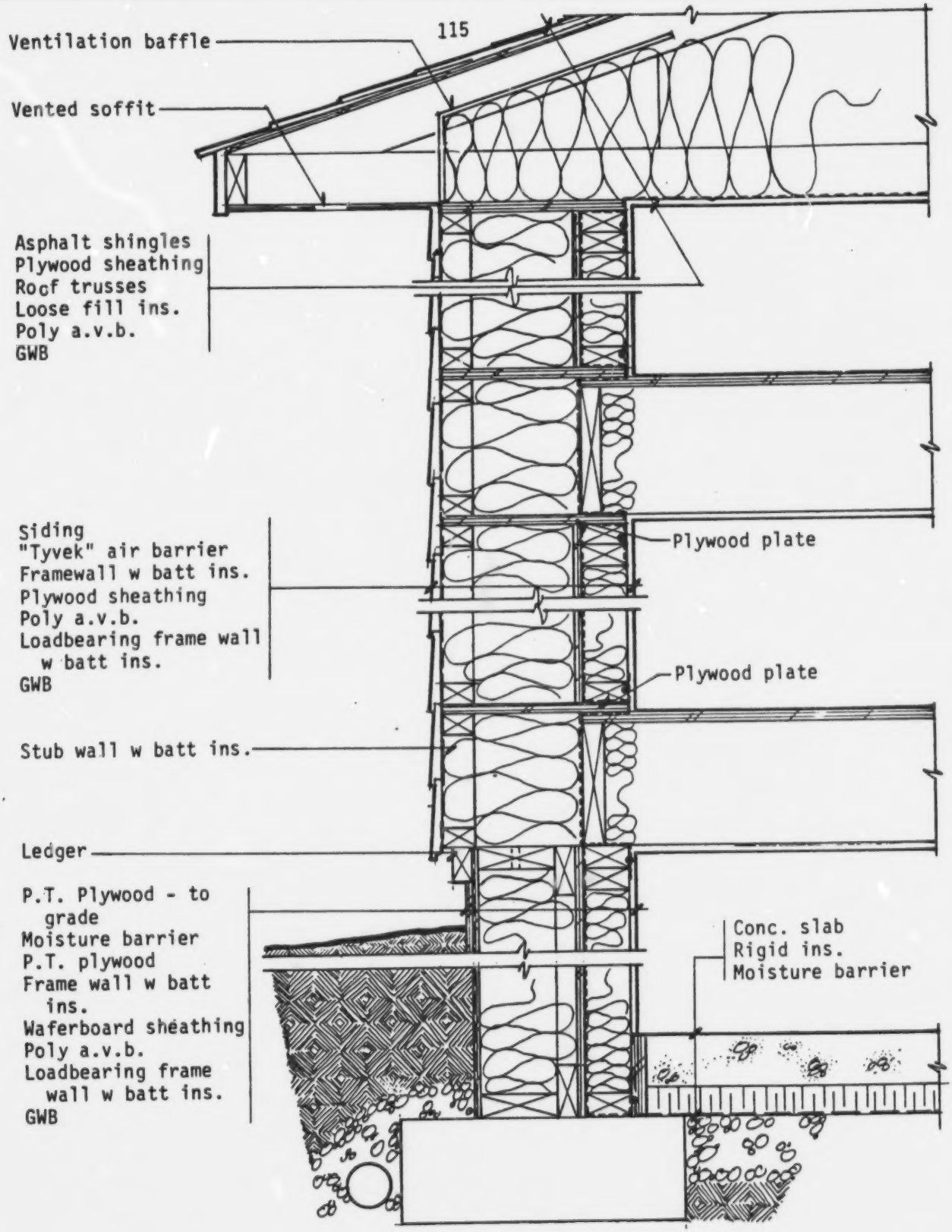
			47	PLAN OF WALL
			48	FOOTING
		49		SILL
			50	INTERMEDIATE FLOOR
		51		WINDOW
			53	EAVE

KEY DETAILS

Refer also to the sections on roofs, openings and penetrations for other applicable details

AGW	BGW	RF	I		DATE	SCALE	DRWG#
51	26	31	--		12/84	1:10	46

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.



AGW	BGW	RF	i		DATE	SCALE	DRWG#
51	26	31	--		12/84	1:10	46

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

PLAN VIEW OF DOUBLE FRAME WALL, INTERIOR WALL LOADBEARING

Both walls are prefabricated and erected as one unit with the polyethylene a.v.b. in place. Wall jacks may be used to assist erection. Note the location of the a.v.b. at the corners.

Technical Performance:

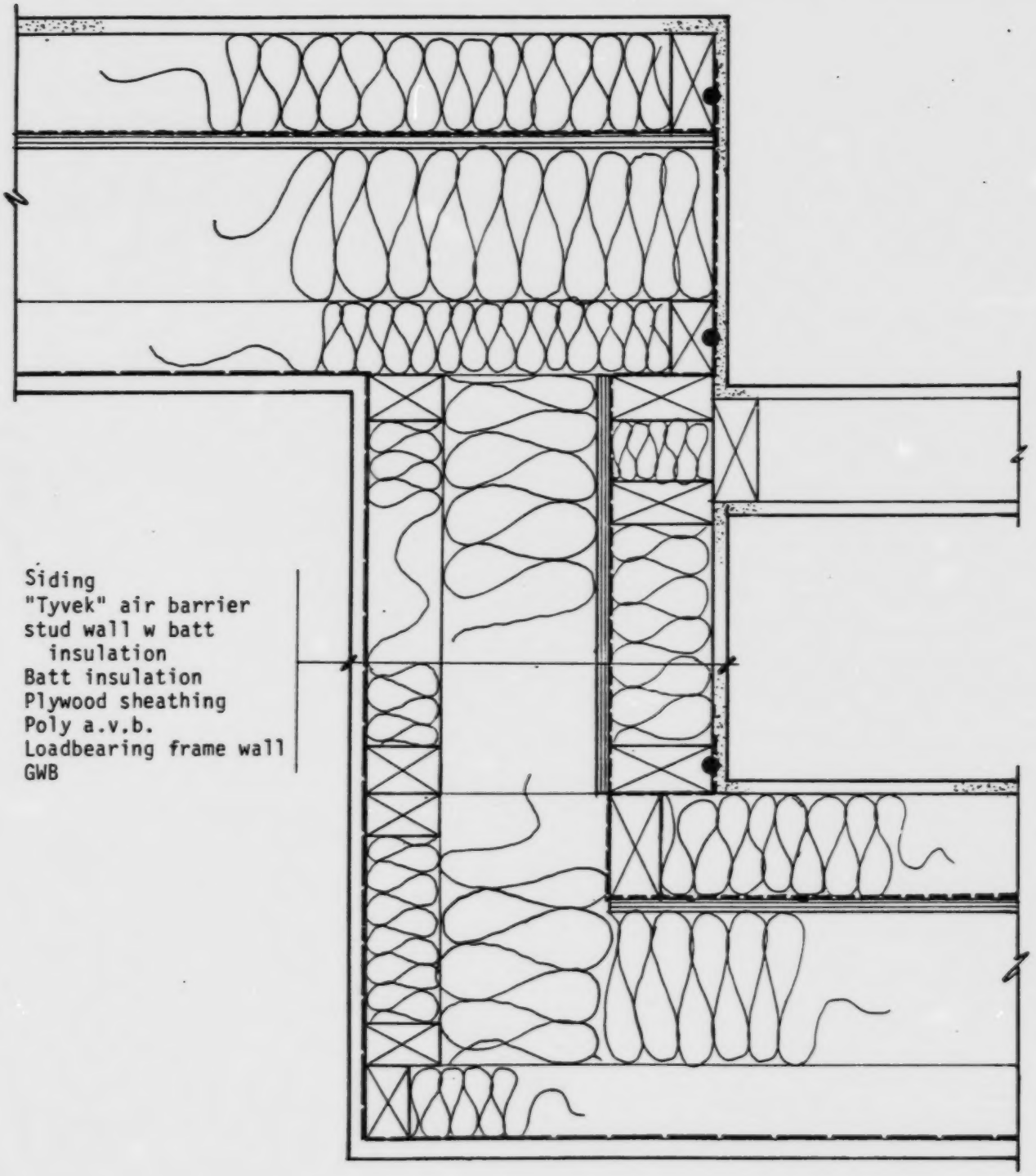
- system permits an effective a.v.b.
- structure is well-protected from temperature fluctuations
- multiple layers of insulation installed as shown reduce risk of convection loops within wall cavity

Practical Application:

- some authorities suggest the polyethylene a.v.b. be eliminated and the plywood sheathing be caulked instead
- plywood top and bottom plates are required
- inner and outer walls are framed at different lengths to accommodate the a.v.b. at corners
- insulation and exterior air barrier or sheathing are installed in the outer portion of the wall prior to erection
- interior work follows normal trade practise

AGW	BGW	RF	I		DATE	SCALE	DRWG#
51	--	--	07		12/84	1:5	47

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
51	--	--	07		12/84	1:5	47

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

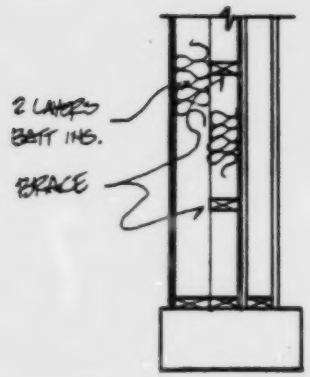
FOOTING SHOWING PRESERVED WOOD FOUNDATION, DOUBLE FRAME VARIATION

The interior loadbearing wall is not pressure treated. Claimed advantages are increased insulation levels, improved airtightness, greater resistance to lateral thrust and the reduction of pressure treated materials.

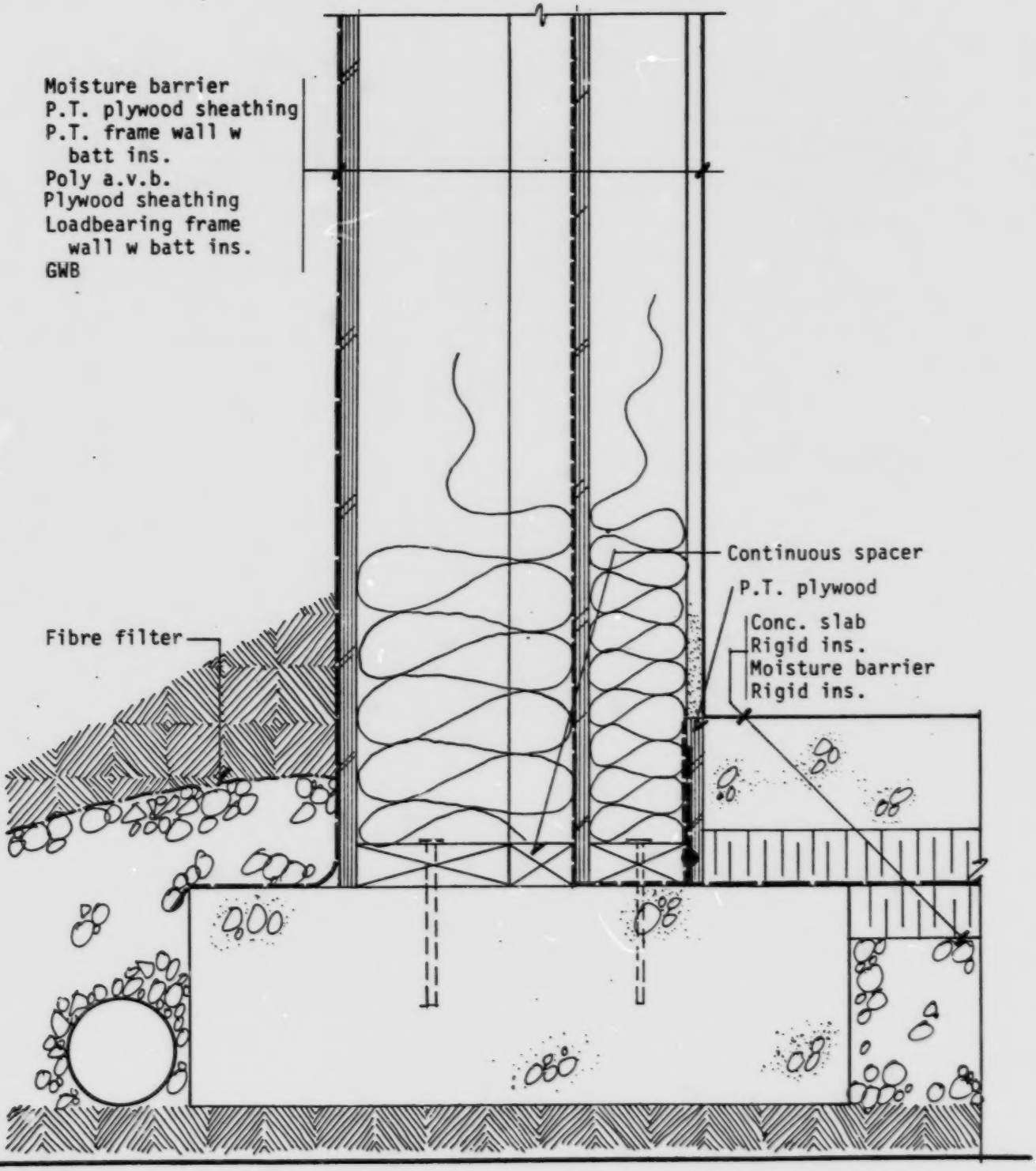
Technical Performance:

- bottom plate of interior wall should be pressure treated
- convection loops are likely to occur behind the 140 mm outer studs where the insulation may not fill the space available

Practical Application:



- since the outer wall is non-loadbearing it could be constructed of 89 mm studs provided they are braced back to the inner wall to provide sufficient resistance to lateral soil pressure (normally four horizontal braces)
- The use of two sheets of rigid board insulation under the floor slab protects the polyethylene moisture barrier but is an uneconomic use of material under normal circumstances



AGW	BGW	RF	I		DATE	SCALE	DRWG#
--	26	--	03		12/84	1:5	48

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

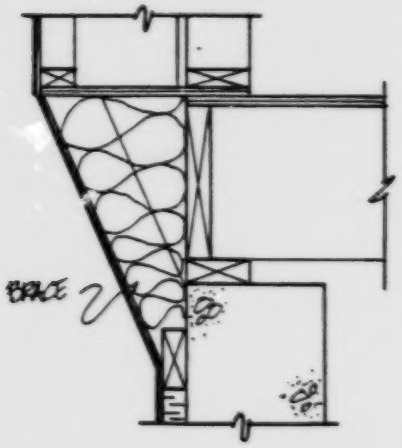
SILL DETAIL, DOUBLE FRAME WALL ON CONCRETE FOUNDATION WITH EXTERIOR INSULATION

The interior load bearing double stud wall assembly shows minimal insulation at the floor joist assembly, in comparison with the wall above. Detail allows for good airtightness.

Technical Performance:

- batt insulation could be fitted between floor joists provided about 2/3 of the total R value of the assembly remains on the outside of the vapour retarder
- foundation wall dampproofing can double as air barrier if joined to polyethylene above
- loadbearing studs are offset from support below. Where joists run parallel to the wall extra support must be provided

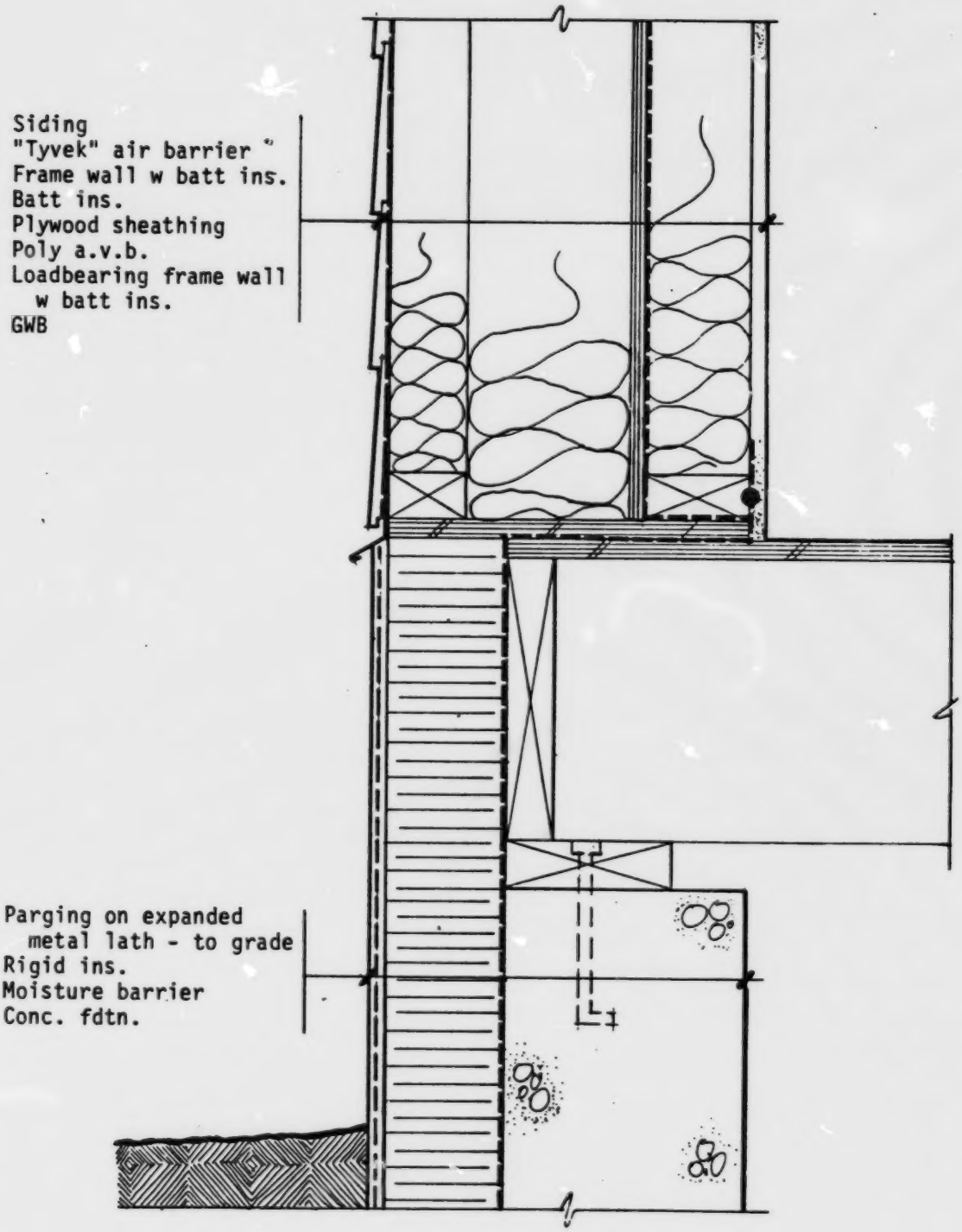
Practical Application:



- the wall assembly is completely prefabricated on the platform
- the technique uses conventional stud lengths and header conditions are also conventional
- a strip of polyethylene must be installed over the header prior to erection of the wall
- this technique reduces interior floor area. A preferable solution would be to overhang the exterior wall from the foundation. This would also solve the bearing problem

AGW	BGW	RF	I		DATE	SCALE	DRWG#
51	21	--	01		12/84	1:5	49

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG #
51	21	--	01		12/84	1:5	49

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

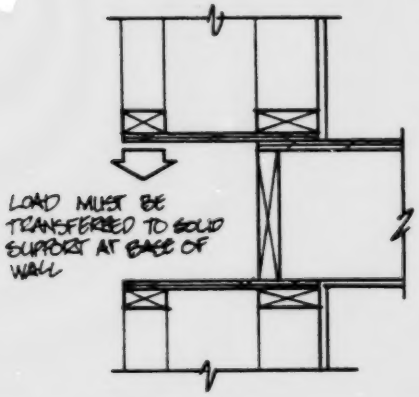
INTERMEDIATE FLOOR JUNCTIONS, DOUBLE FRAME
INTERNAL WALL LOADBEARING

This detail has minimal thermal bridging and good airtightness characteristics.

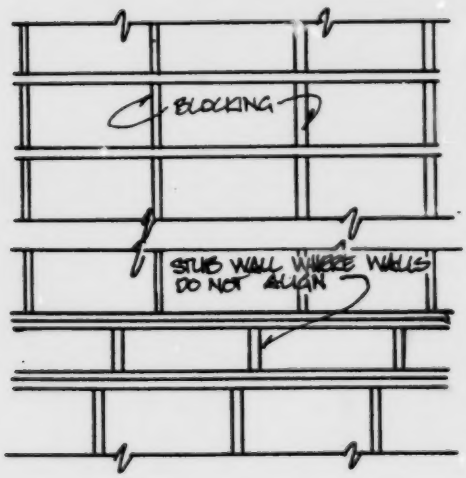
Technical Performance:

- plywood top and bottom plates act only to separate inner and outer walls and should not be expected to support the outer wall

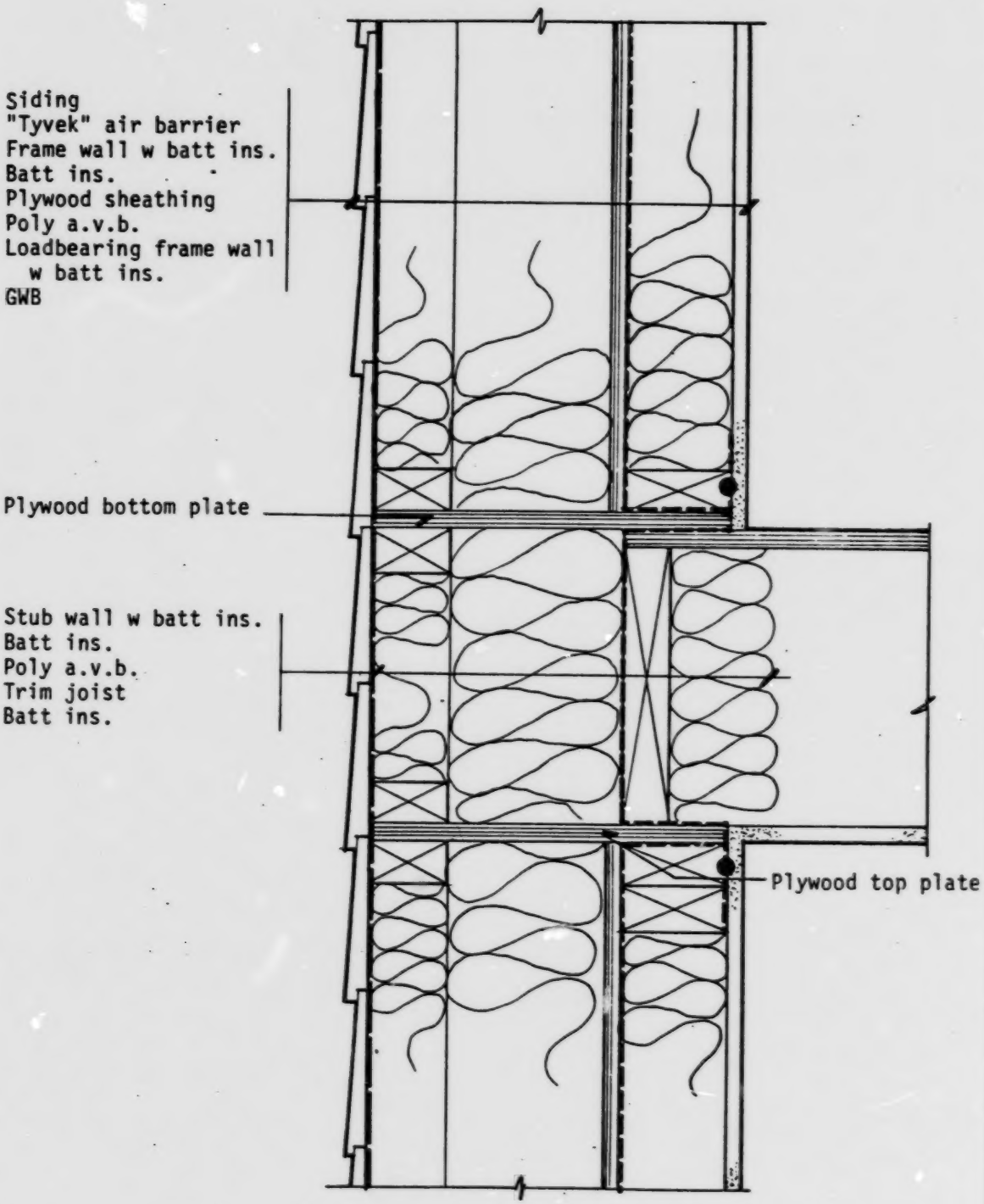
Practical Application:



- a polyethylene strip must be installed over the plywood top plate of the first floor wall prior to joist placement. This strip must be protected from damage during subsequent work, and may be slippery to work on
- some builders use 89 mm studs and double top plates for both inner and outer walls to simplify framing logistics and to permit the use of precut stock throughout
- plywood plates may be reduced in thickness
- the system may be reduced in cost by using thinner plywood for top and bottom plates



- provided lower and upper wall studs are aligned the stub wall may be eliminated and short blocks inserted under each stud to transfer loads from upper to lower wall
- location of inside face of wall should be marked on subfloor prior to wall erection to simplify placement
- some authorities suggest eliminating the polyethylene a.v.b. and caulking the plywood instead



AGW	BGW	RF	I		DATE	SCALE	DRWG#
51	--	--	06		12/84	1:5	50

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

RECESSED WINDOW DETAIL IN DOUBLE FRAME WALL, INTERIOR WALL LOADBEARING

This detail has a plywood liner in the rough frame opening, sloped at the sill to provide drainage. The window is installed in the inner, loadbearing wall.

Technical Performance:

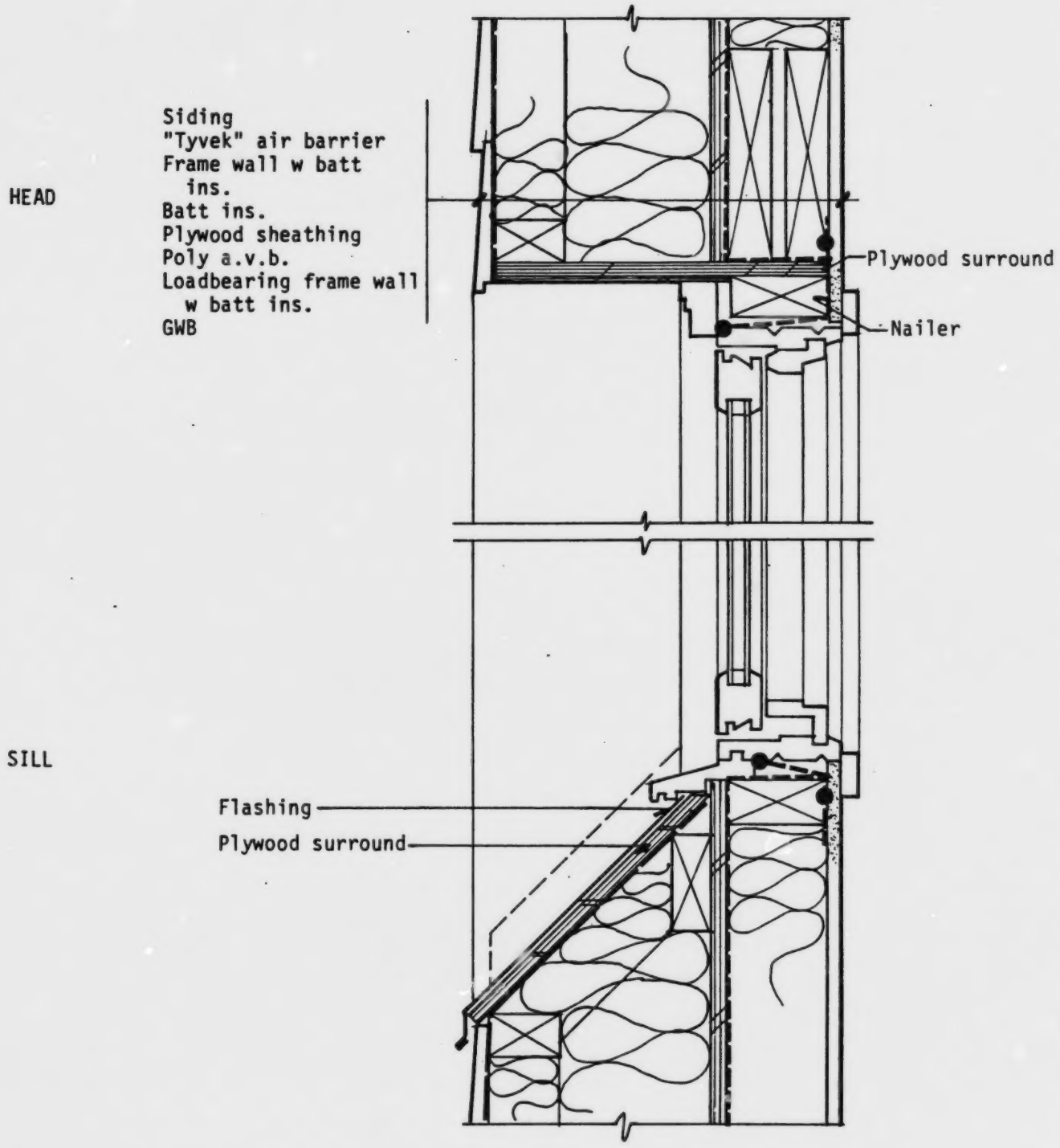
- the location of the window in the interior loadbearing wall is preferable from a structural standpoint and also protects the window from weather to some extent
- the window recess shades south facing windows, reducing available passive solar gain

Practical Application:

- frame opening is taller in exterior wall than interior wall and must be correctly aligned
- special flashings and trim are required to finish the exterior opening, and must be correctly installed to avoid water damage
- interior finishes are conventional

AGW	BGW	RF	I		DATE	SCALE	DRWG#
51	--	--	22		12/84	1:5	51

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.



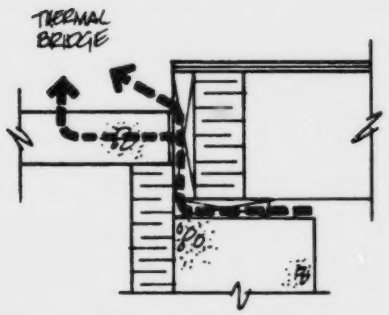
AGW	BGW	RF	I		DATE	SCALE	DRWG#
51	--	--	22		12/84	1:5	51

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

DOOR DETAIL IN DOUBLE FRAME WALL, INTERIOR WALL LOADBEARING

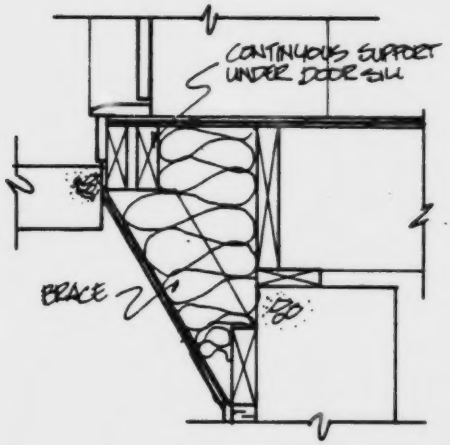
This detail illustrates some problems incurred when this wall system is inset on concrete foundation.

Technical Performance:



- the interior bearing wall is inset with respect to the foundation and load paths are indirect. Special provision for structural support must be made where joists run parallel to the exterior wall
- thermal bridging occurs at the precast concrete step

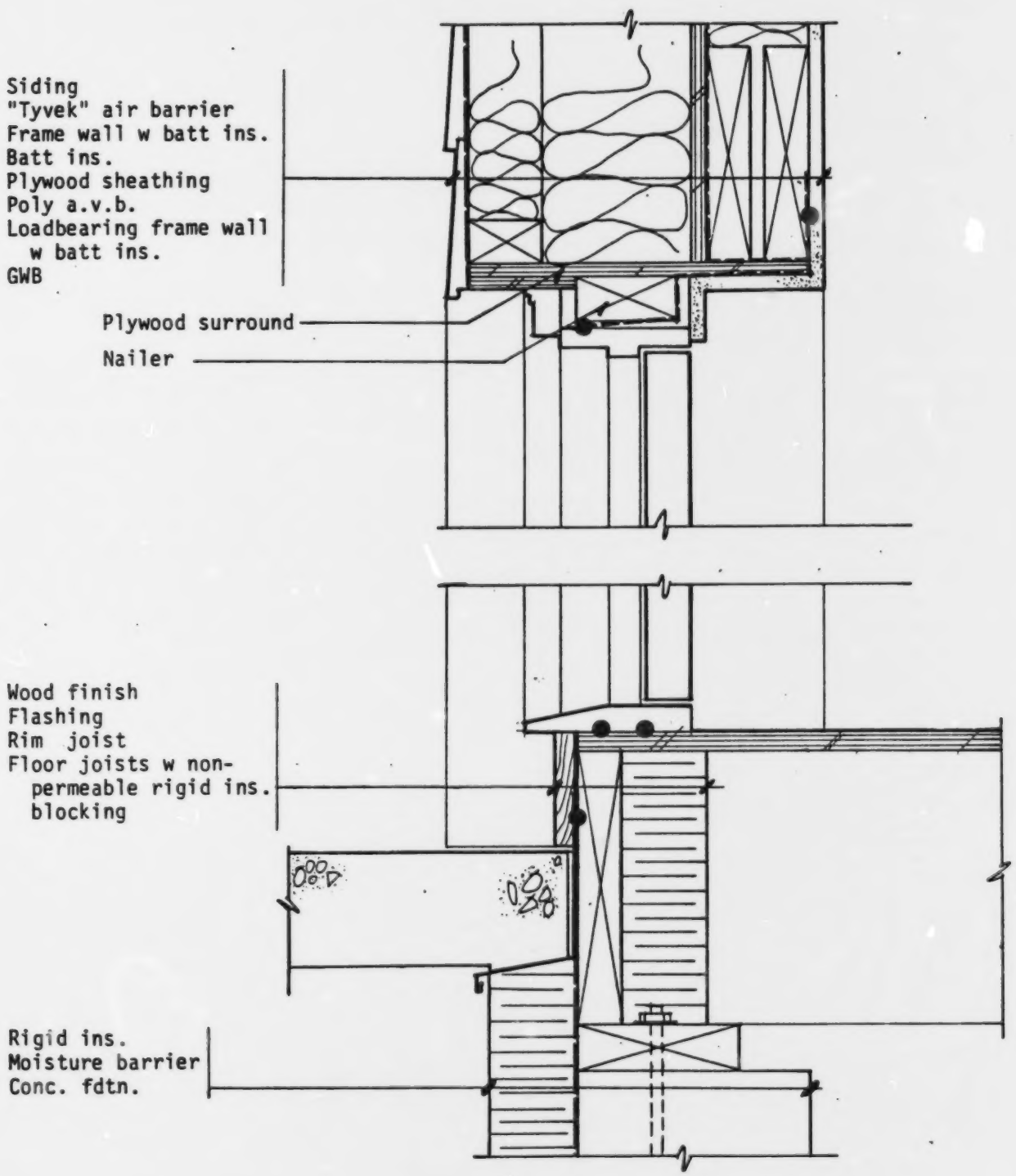
Practical Application:



- an alternative solution would be to align the internal bearing wall on the concrete foundation and mount the door in the exterior non-load bearing wall. This wall must then be supported on brackets tied back to the concrete foundation

AGW	BGW	RF	I		DATE	SCALE	DRWG #
51	21	--	25		12/84	1:5	52

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
51	21	--	25		12/84	1:5	52

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

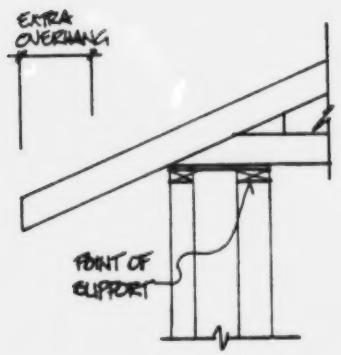
EAVE DETAIL, RAISED HEEL TRUSS ON DOUBLE FRAME INTERIOR WALL LOADBEARING

This detail shows adequate insulation levels and good airtightness characteristics.

Technical Performance:

- a solid insulation retainer must be provided as shown to prevent heat loss and potential condensation problems by 'blow through'
- the truss must be designed to bear on the interior loadbearing wall, not the exterior wall

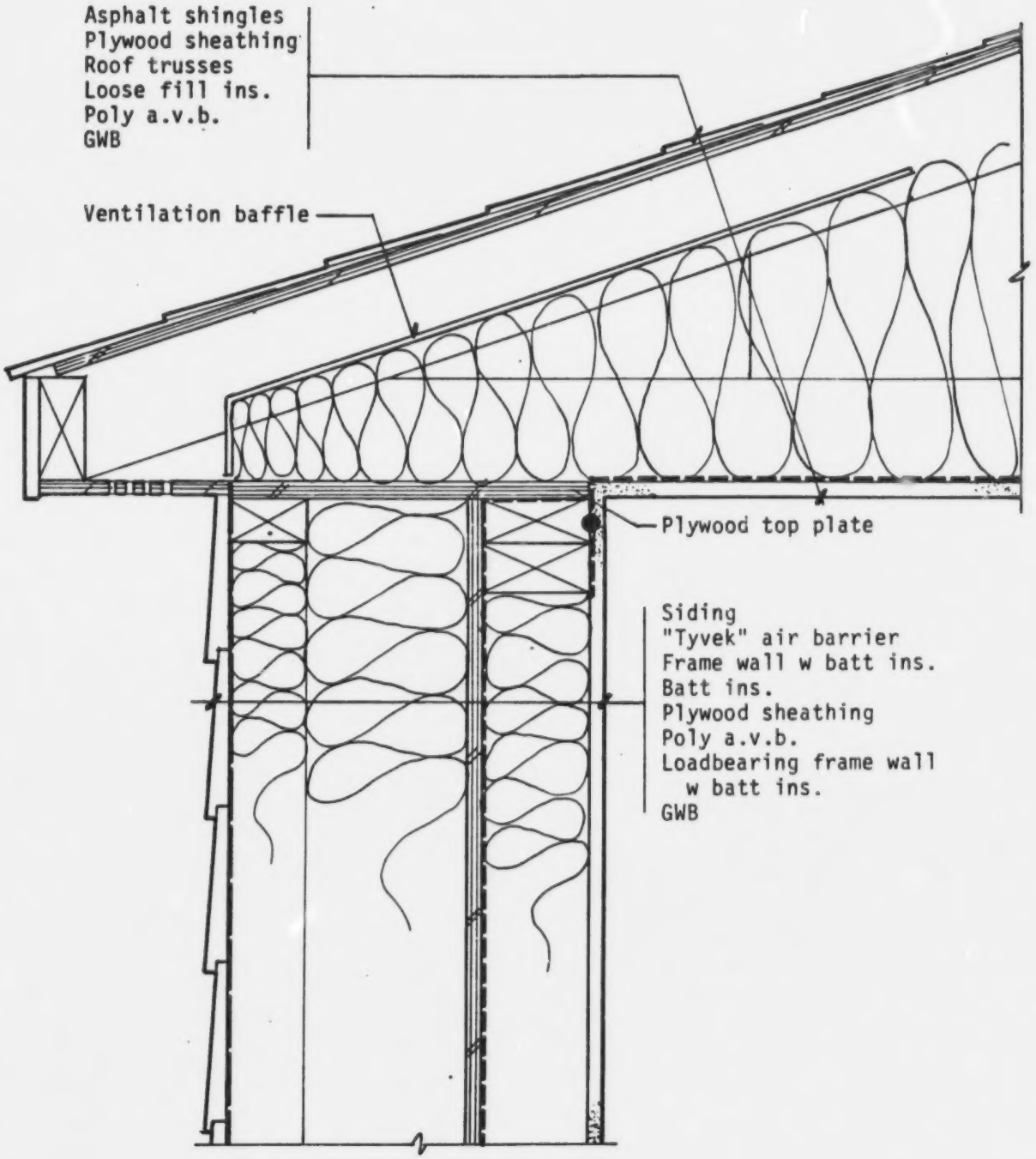
Practical Application:



- the eave overhang as shown is short, because the manufacturer has supplied a standard overhang from the bearing portion of the truss. Additional overhang should be specified if conventional eave widths are required
- Note the protection of the a.v.b. by plywood top plate

AGW	BGW	RF	I		DATE	SCALE	DRWG#
51	--	31	10		12/84	1:5	53

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
51	--	31	10		12/84	1:5	53

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

In this case the non-loadbearing walls are prefabricated and erected separately from the inner loadbearing walls. This eliminates the need for plywood wall plates and may marginally reduce other materials. However labour requirements are increased. Variations of the technique are appropriate for exterior retrofits and the method is of interest for this reason.

Technical Performance:

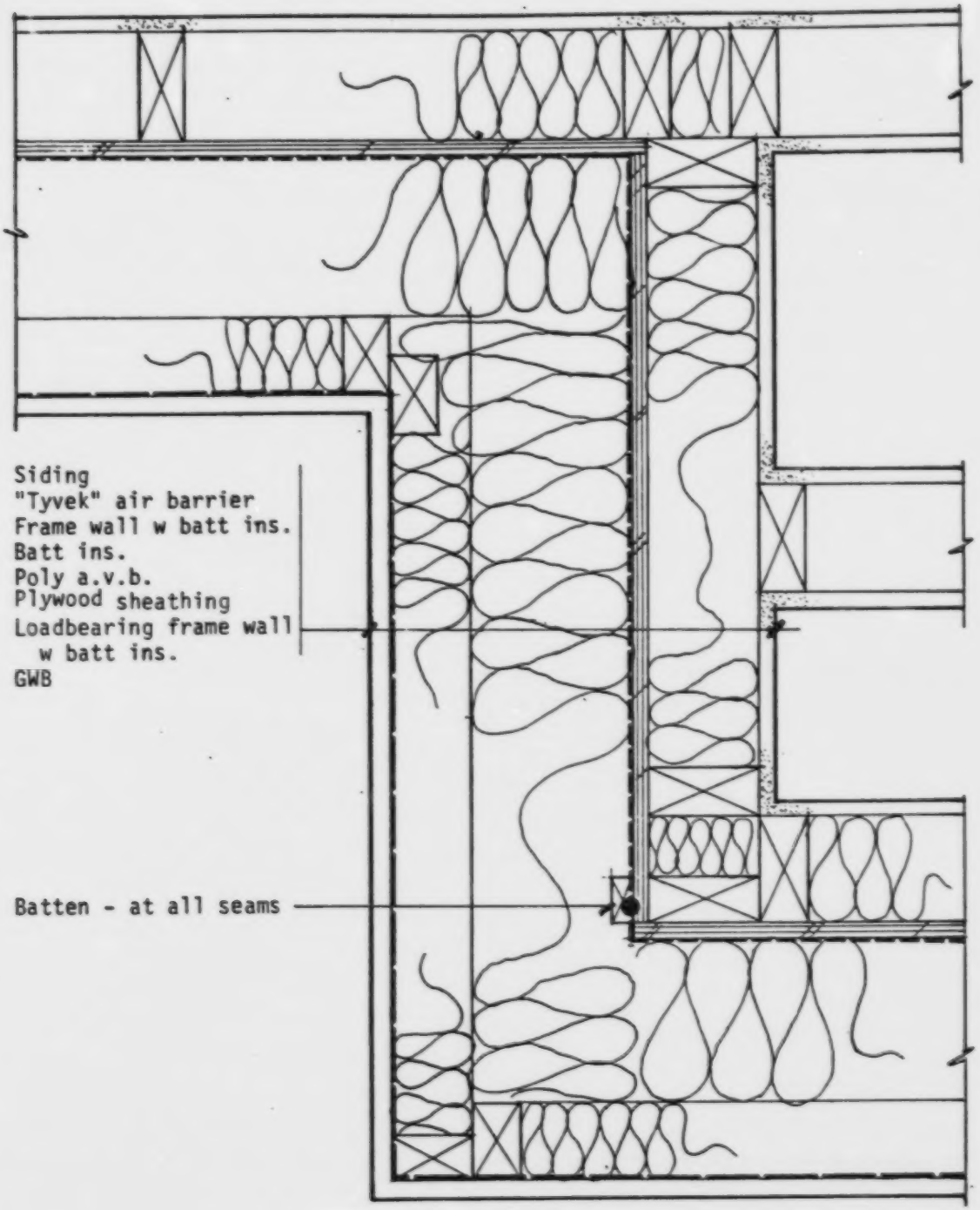
- adequate structural support must be provided for the exterior non loadbearing wall
- the polyethylene air-vapour barrier is exposed to the elements during construction and should be u.v. stabilized
- the polyethylene air-vapour barrier should be structurally supported with battens

Practical Application:

- the outer framing may be applied after the conventional inner framing has been completed
- alternatively, the cutting and prefabrication of the inner and outer walls may be done simultaneously and the outer walls lifted into place after the polyethylene air-vapour barrier is installed
- in either case windows and other openings must be properly aligned

AGW	BGW	RF	I		DATE	SCALE	DRWG#
52	--	--	07		12/84	1:5	54

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
52	--	--	07		12/84	1:5	54

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

EAVE, RAISED HEEL TRUSS ON DOUBLE FRAME, INTERIOR LOADBEARING VARIATION

This detail shows a double frame variation in which inner and outer walls are framed and erected separately. The truss has a steeper pitch than other examples which permits higher insulation levels at the eave. These levels decrease as the roof pitch is lowered. Note protection of air-vapour barrier and the use of strapping to permit ceiling fixtures.

Technical Performance:

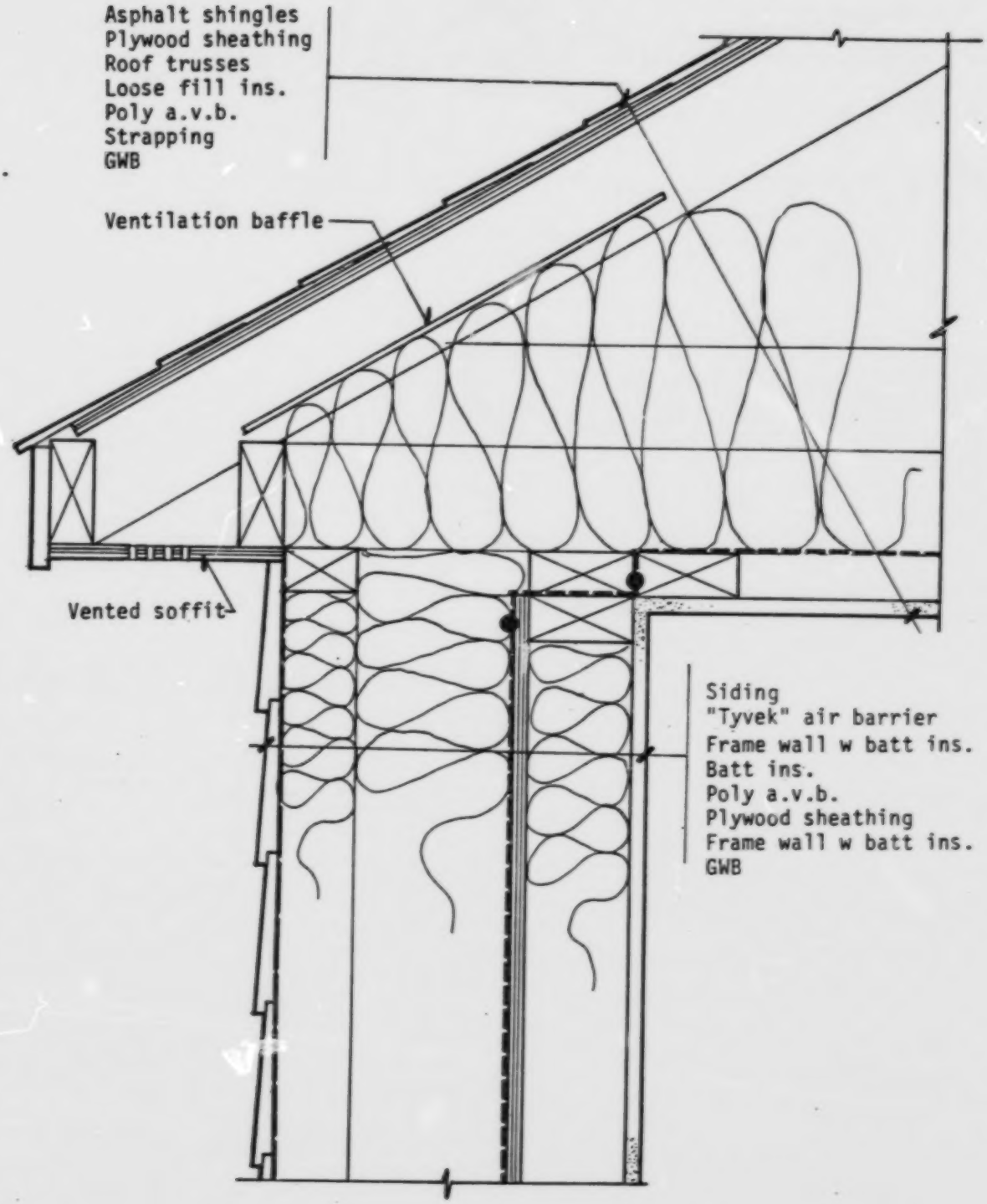
- wall polyethylene must be u.v. stabilized and supported with battens
- the ventilation baffle should be continuous with the blocking shown at insulation retainer to block passage of wind into the insulation
- any convection which occurs in the outer wall cavity can continue into the roof cavity because of the absence of a plywood plate or other other air barrier
- truss must be designed to bear on the inner loadbearing wall

Practical Application:

- ceiling strapping may be eliminated if there are no electricals in the ceiling provided drywall is thick enough to resist sagging
- a strip of polyethylene must be installed between top plates of bearing wall

AGW	BGW	RF	I		DATE	SCALE	DRWG #
52		31	10		12/84	1:5	55

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
52		31	10		12/84	1:5	55

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

BUILDING SECTION WITH DOUBLE FRAME WALL, EXTERIOR FRAME LOADBEARING ON INSULATED FLOOR SLAB

The building section shown illustrates the following combination of systems:

Slab on grade foundation
Double frame wall exterior frame loadbearing
Raised heel standard truss

This combination of systems is appropriate when a full basement is not required and high R values are desired but weather conditions preclude the use of weather dependent wall types. The intermediate floor junction detail is weak; the system is better suited to single storey designs.

Nominal RSI: 7.0 Modified RSI: 6.7

System Advantages:

- house can be framed and closed conventionally
- system uses standard stock

System Disadvantages:

- interior floor space is lost.
- unbroken thick wall cavity is conducive to the formation of convective cells
- carpenters must return when house is partially insulated to complete interior framing and partitions.
- wiring perforates the air-vapour barrier which is subject to damage when located as shown

All AGW 53 drawings describe this wall type.

DRAWING #

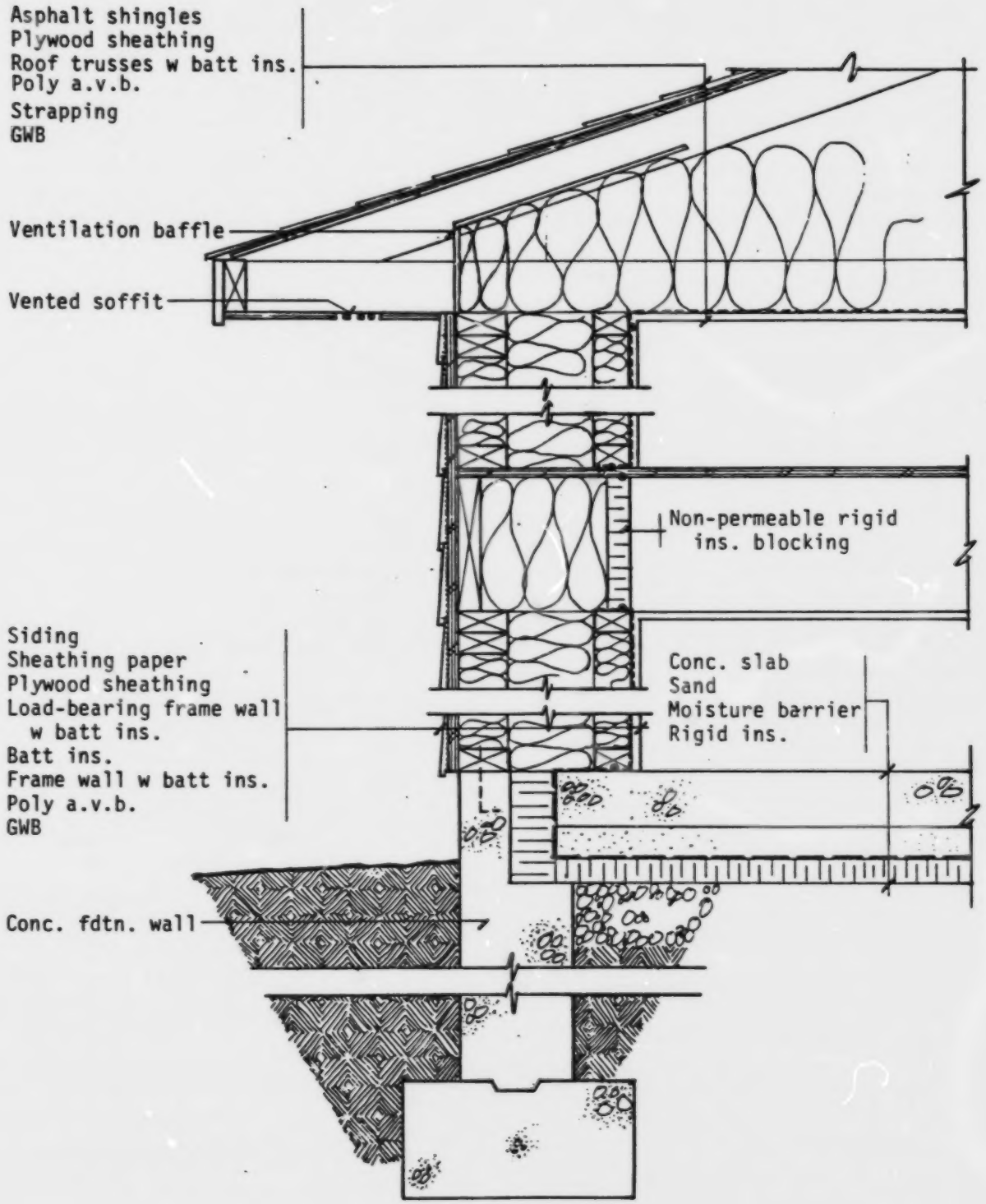
			57	PLAN OF WALL
60	59	58		FOOTING
60	59	58		SILL
				INTERMEDIATE FLOOR
		61		WINDOW
				EAVE

KEY DETAILS

Refer also to the sections on roofs, openings and penetrations for other applicable details

AGW	BGW	RF	I		DATE	SCALE	DRWG #
53	20	31	--		12/84	1:10	56

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
53	20	31	--		12/84	1:10	56

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

PLAN OF DOUBLE FRAME WALL,
EXTERIOR WALL LOADBEARING

This detail shows a conventional 38 x 89 frame with an inner 38 x 64 wall framed up in the inside after close in. The polyethylene air-vapour barrier is mounted immediately behind the drywall.

Technical Performance:

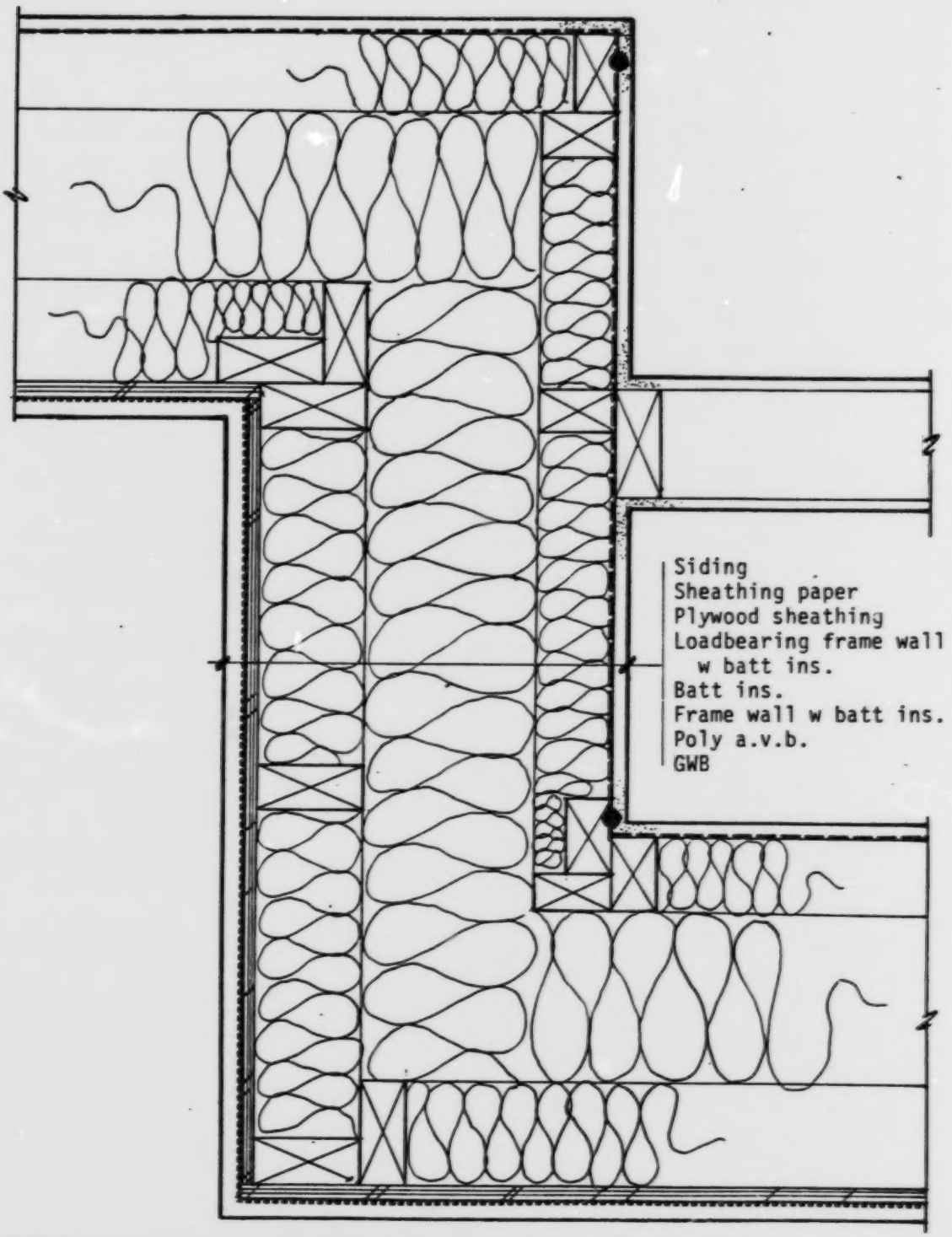
- thick undivided wall cavity is prone to convective cell formation unless insulation is carefully installed
- polyethylene air-vapour barrier is more prone to damage in this location than if recessed

Practical Application:

- polyethylene air-vapour barrier must be continuous behind partitions and sealed at all electrical penetrations. Joints must occur over solid backing
- wall batts are applied in two stages; two layers immediately after close in and one layer after framing of interior wall

AGW	BGW	RF	I		DATE	SCALE	DRWG#
53	--	--	07		12/84	1:5	57

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



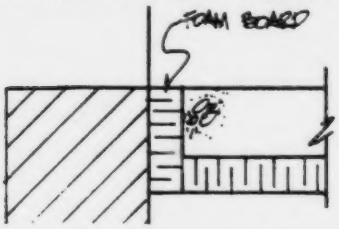
AGW	BGW	RF	I		DATE	SCALE	DRWG#
53	--	--	07		12/84	1:5	57

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

INSULATED FLOOR SLAB WITH DOUBLE FRAME WALL VARIATION ON INSULATED BLOCK FOUNDATION

This detail may be used as an alternative to that shown in the building section. It shows an insulated block wall 'Sparfil'™ i.e. concrete blocks with polystyrene bead aggregate, resting on a shallow footing. The wall above is double frame, exterior loadbearing.

Technical Performance:



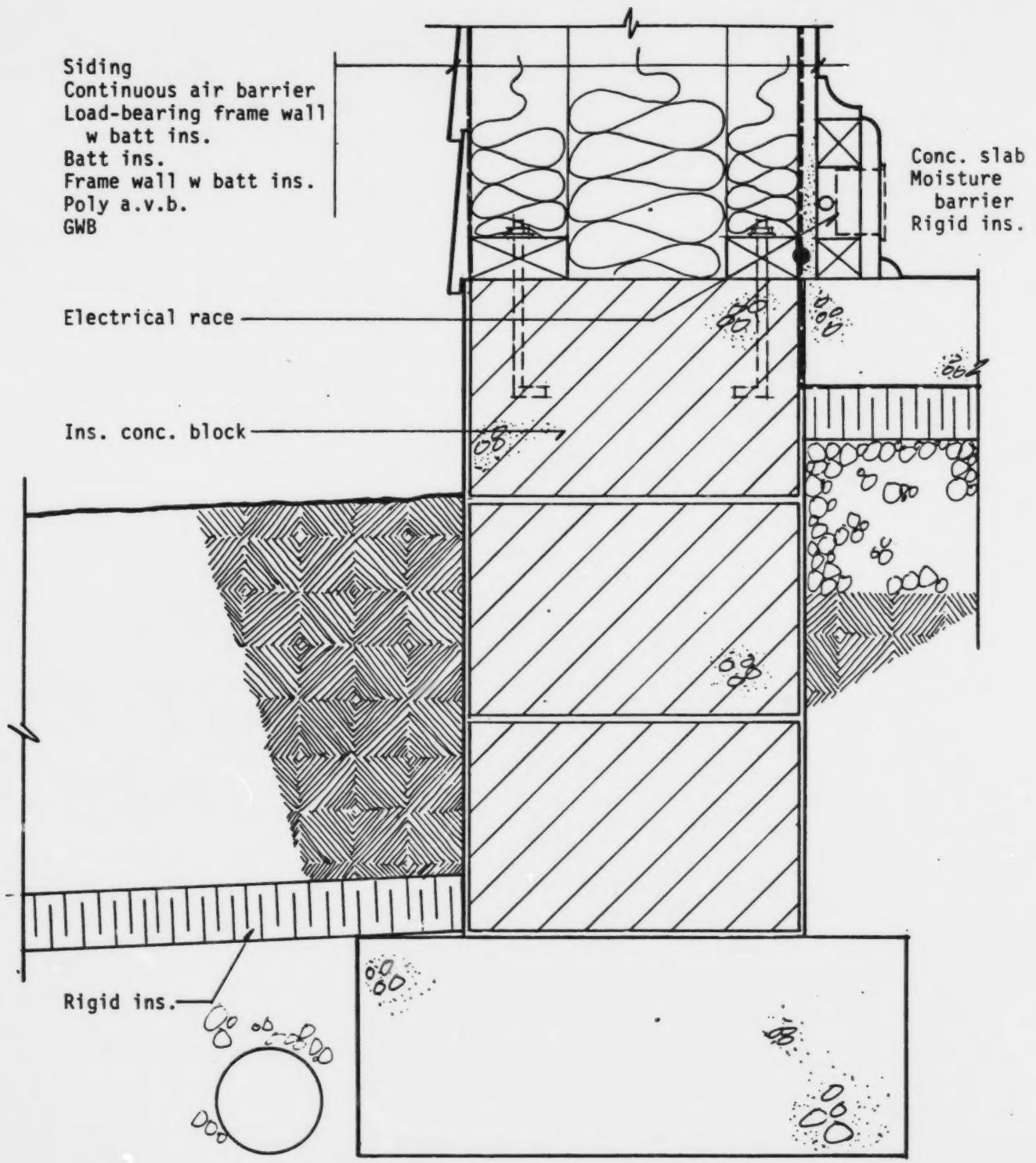
- thermal performance would be improved with the addition of foam board at the slab edge
- horizontal insulation over the footing as shown is necessary to prevent frost penetration

Practical Application:

- 'Sparfil'™ blocks or equivalent may not be available in all areas
- drawing shows electrical race concealed in baseboard, conventional wiring could be substituted provided all perforations in the air-vapour barrier are sealed
- the above grade wall type, double frame exterior loadbearing, is best suited to single storey designs with slab on grade foundations

AGW	BGW	RF	I		DATE	SCALE	DRWG#
53	24	--	01		12/84	1:5	58

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
							58

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

SILL DETAIL, DOUBLE FRAME WALL ON CONCRETE FOUNDATION WITH INTERIOR INSULATION

This variation shows an exterior loadbearing double frame wall on a concrete foundation. The polyethylene air-vapour barrier is located immediately behind the drywall.

Technical Performance:

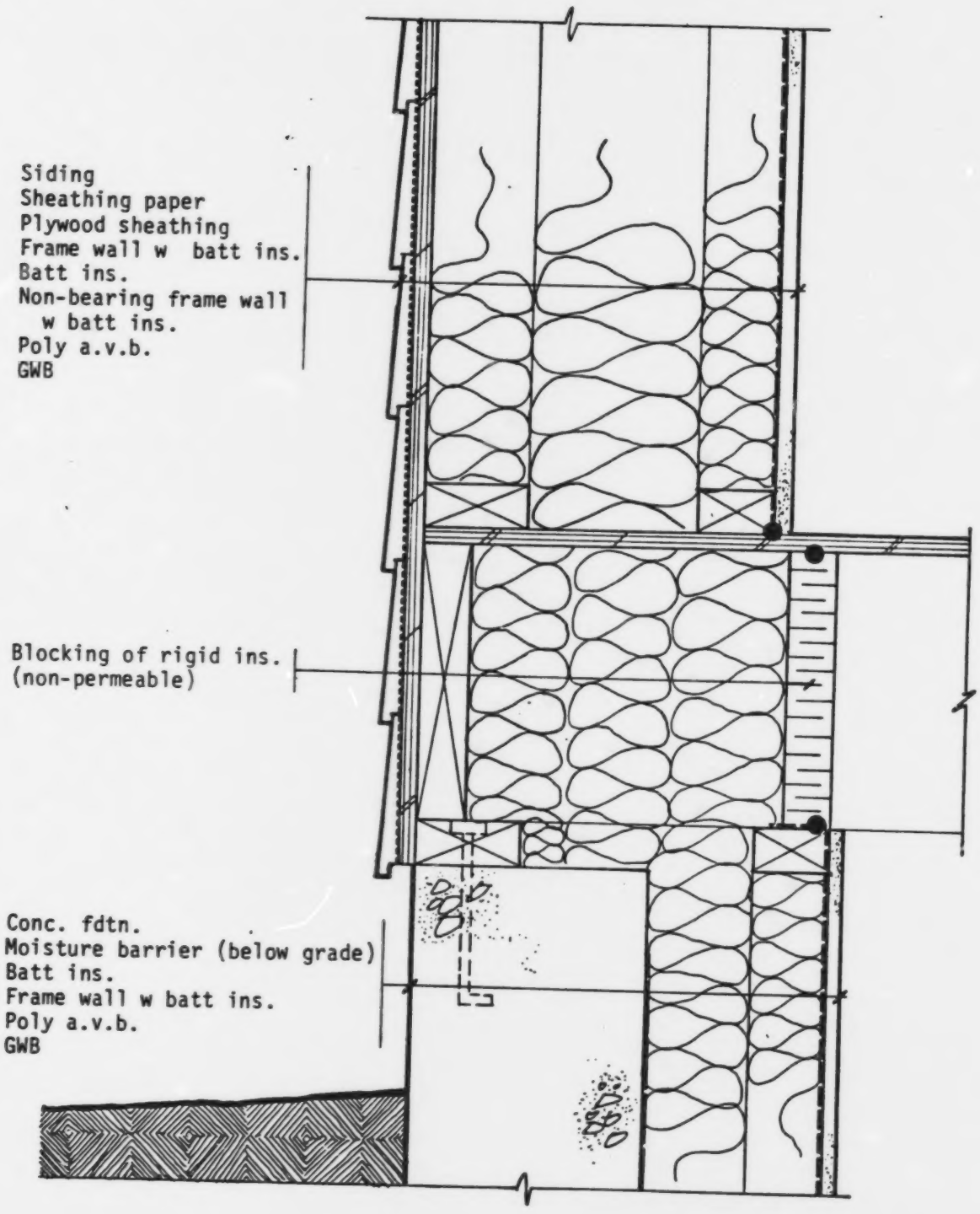
- soils must be well-drained to avoid frost action on foundations in colder climates
- the detail is likely to be less airtight than other header sealing methods

Practical Application:

- header sealing is difficult to achieve; subfloor must be glued or caulked at perimeter. Extruded polystyrene blocks must be cut accurately and caulked in place
- wiring and other services are located behind the air-vapour barrier which must be sealed at each penetration

AGW	BGW	RF	I		DATE	SCALE	DRWG#
50	22	--	01		12/84	1:5	59

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
50	22	--	01		12/84	1:5	59

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

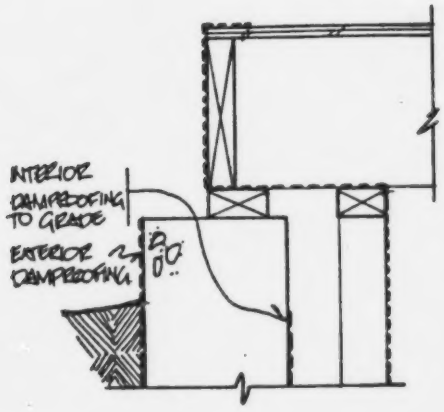
SILL DETAIL DOUBLE FRAME WALL ON CONCRETE FOUNDATION WITH INTERIOR INSULATION VARIATION SHOWING BRICK VENEER

This detail is similar to the previous drawing except that brick cladding is shown as the exterior finish, supported on a steel angle bolted to the foundation.

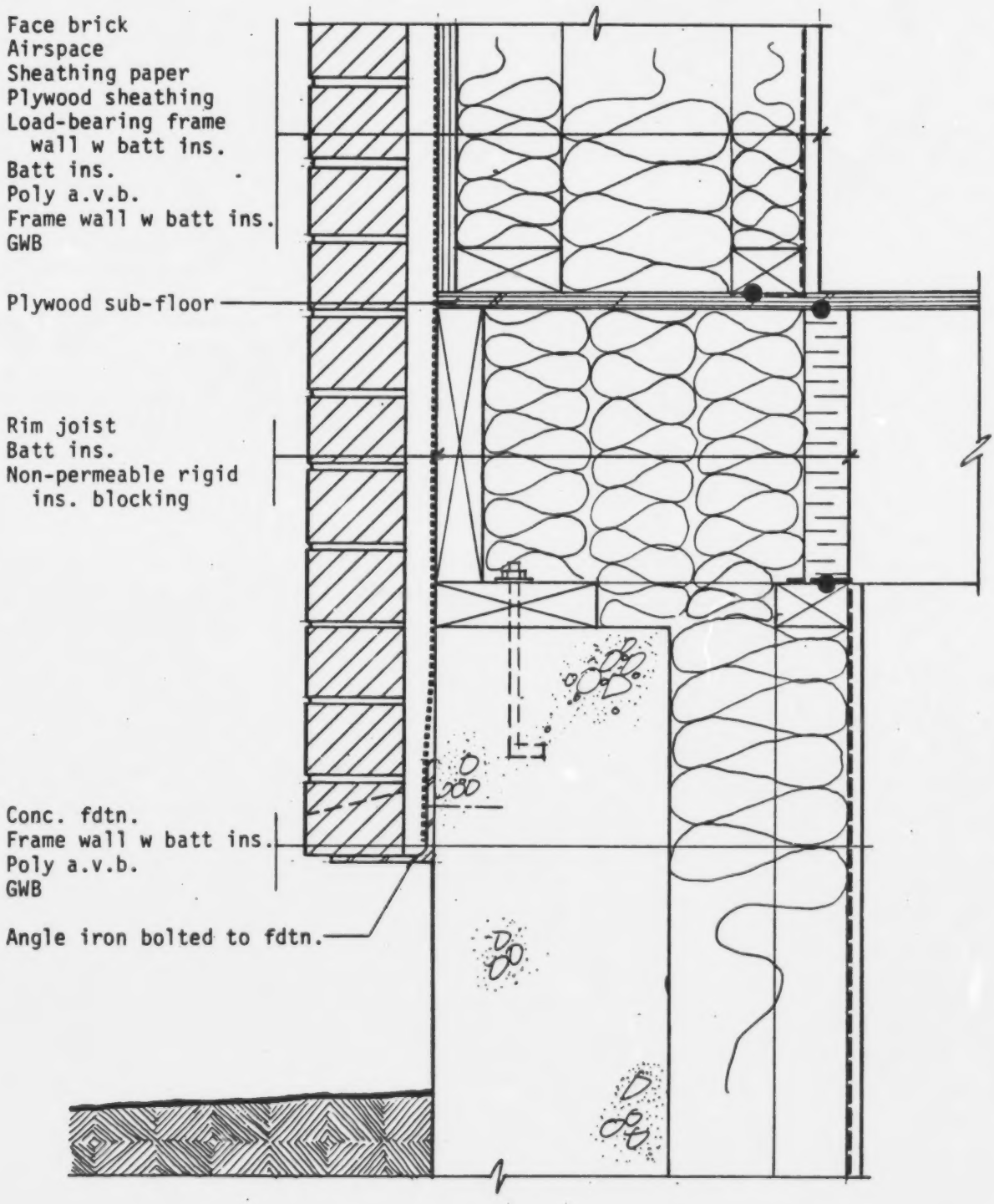
Technical Performance:

- this detail shows one way of supporting brick veneer without creating a thermal bridge at the brick support. Note that this method will not work without interior basement insulation
- steel angle must be adequately fastened to the foundation
- soils must be well-drained to avoid frost action on foundations in colder climates
- the detail is likely to be less airtight than other header sealing methods
- proper moisture protection must be provided below grade

Practical Application:



- header sealing is difficult to achieve; subfloor must be glued or caulked at perimeter. Extruded polystyrene blocks must be cut accurately and caulked in place
- wiring and other services are located behind the air-vapour barrier which must be sealed at each penetration
- polyethylene moisture barrier should be installed behind the batt insulation to grade
- two layers of batt insulation below grade will function better than one



AGW	BGW	RF	I		DATE	SCALE	DRWG#
53	22	--	01		12/84	1:5	60

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

WINDOW DETAIL IN DOUBLE FRAME WALL, EXTERIOR WALL LOADBEARING

Plywood jamb extensions are fastened to the window, which is then wrapped in polyethylene and inserted in the rough frame opening.

Technical Performance:

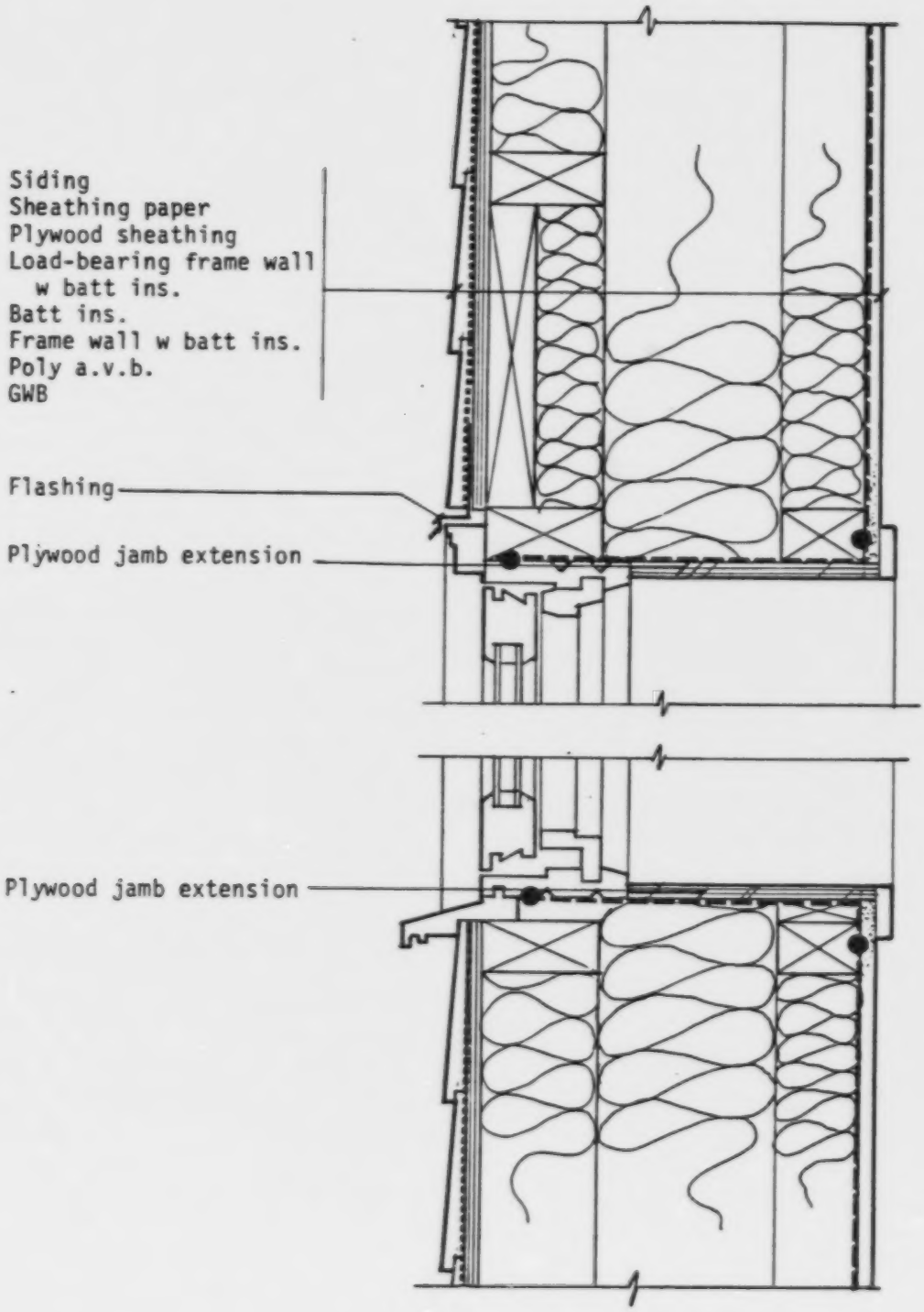
- outer and inner walls must be solidly fastened together at window and door openings

Practical Application:

- window wrap must be correctly installed
- inner framing will be simpler to install if done after windows are in place
- if plywood jamb extension was used as wall, polyethylene window wrap could be eliminated and plywood would also provide bracing

AGW	BGW	RF	I		DATE	SCALE	DRWG#
53	--	--	22		12/84	1:5	61

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG #
53	--	--	22		12/84	1:5	61

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

PLAN SECTION OF DOUBLE FRAME WALL, EXTERIOR LOADBEARING

In this technique a conventional frame is erected, closed in and insulated. An additional layer of horizontal batts is stapled to the inside of the frame. An interior wall is then framed and insulated.

Technical Performance:

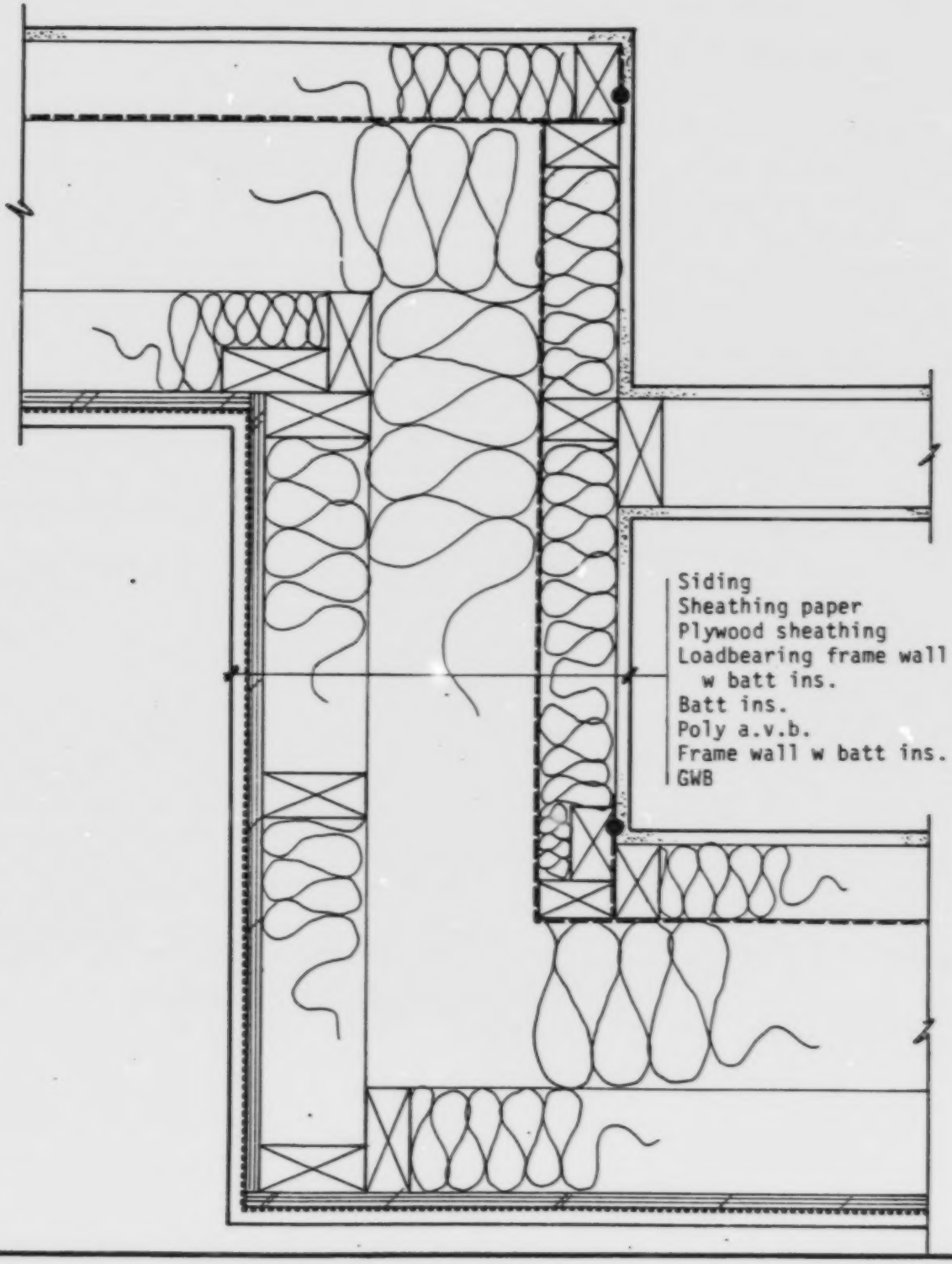
- with the polyethylene air-vapour barrier located as shown thermal performance and airtightness are good
- battens should be installed to support the polyethylene
- some builders locate the air-vapour barrier immediately behind the drywall. This may result in reduced wall R value due to large convective cells within the deep wall cavity. It is preferable to divide the cavity into sections as shown. In addition, electrical wiring and other service penetrations are likely to reduce the airtightness of the wall

Practical Application:

- interior walls must be framed short to permit erection, and shimmed in place
- polyethylene must be installed on the outside surface of the interior wall prior to erection of the wall
- it is difficult to achieve good airtightness detailing at corners and openings
- it may be more practical to locate the air-vapour barrier immediately behind the drywall and suffer the technical performance consequences described above. In this case the interior wall may be framed in place rather than be prefabricated

AGW	BGW	RF	I		DATE	SCALE	DRWG#
54	--	--	07		12/84	1:5	62

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



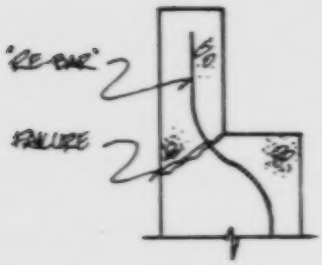
AGW	BGW	RF	I		DATE	SCALE	DRWG#
54	--	--	07		12/84	1:5	62

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

INSULATED FLOOR SLAB WITH DOUBLE FRAME WALL VARIATION

This detail successfully isolates the floor slab and shows a good application for the double frame exterior wall loadbearing system.

Technical Performance:



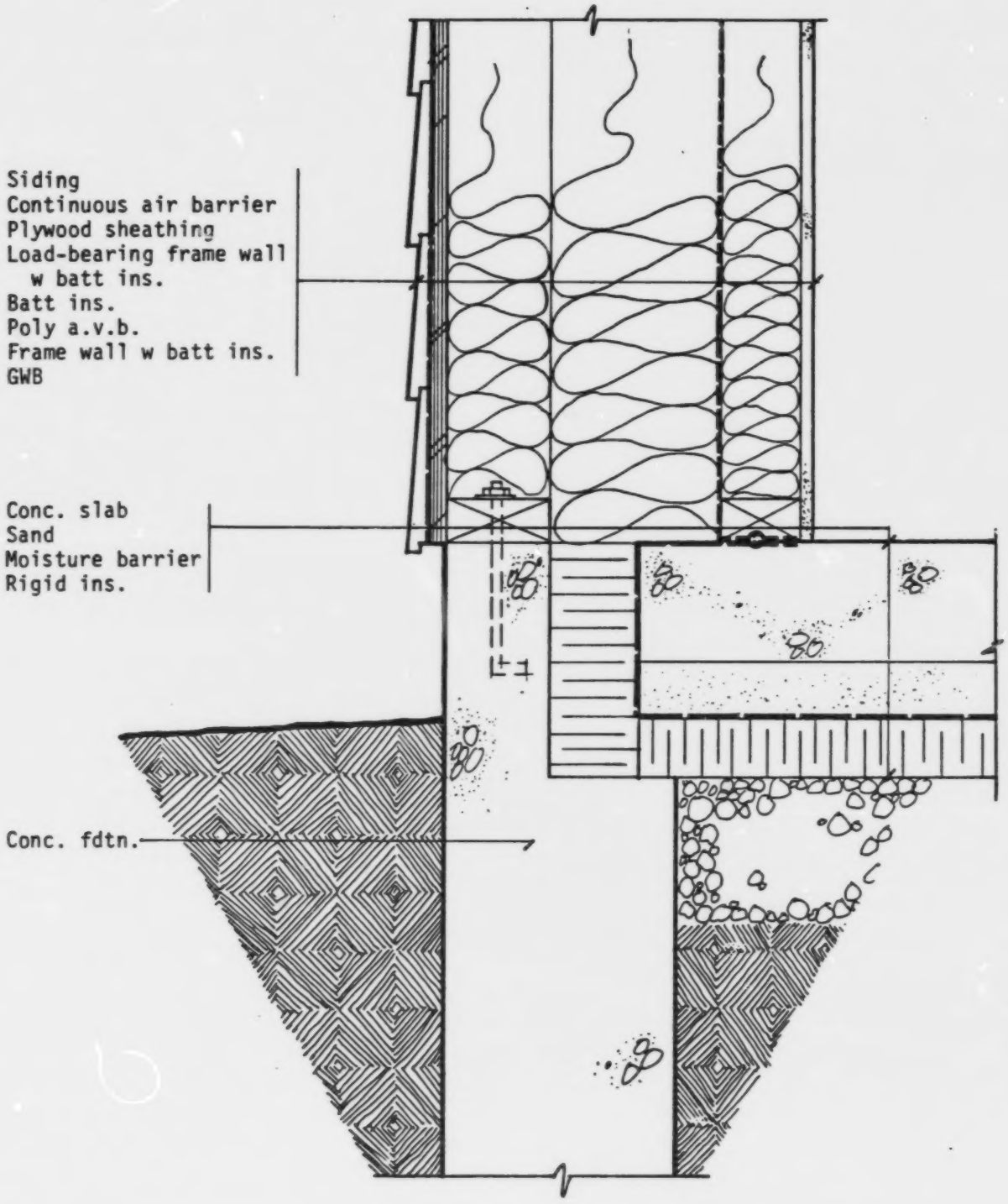
- outer bearing portion of concrete wall must be adequately reinforced to prevent shear failure
- in colder region exterior rigid board insulation will be required to prevent frost penetration
- footings must be protected from freezing and normal good practice followed for drainage and moisture protection

Practical Application:

- interior wall is framed after the building is closed in
- air-vapour barrier is installed on prefabricated interior wall which must be framed short to permit erection and shimmed in place
- air-vapour barrier must be supported with battens; continuity at windows and other openings is difficult to achieve
- much trades' coordination is required (slab, plumbing and other services, insulation, framers)

AGW	BGW	RF	I		DATE	SCALE	DRWG#
54	20	--	01		12/84	1:5	63

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
54	20	--	01		12/84	1:5	63

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

INTERMEDIATE FLOOR JUNCTION, DOUBLE FRAME, EXTERIOR WALL LOADBEARING

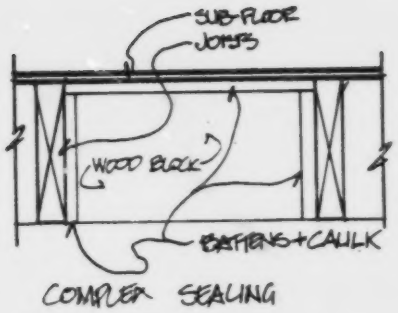
This detail demonstrates the difficulties of building two storey houses using this wall framing technique. Reasonable insulation levels but questionable method of air sealing between floors. Considerable time must be spent installing and caulking blocking at each joist cavity. Fire stop between top plates is redundant.

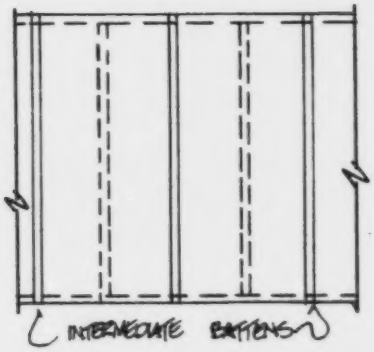
Technical Performance:

- battens are required at each joist and behind the wall air-vapour barrier to support the polyethylene

Practical Application:

- this technique is very difficult to execute correctly and is prone to error
- it is simpler to locate the air-vapour barrier immediately behind the drywall and seal all electrical penetrations
- extruded polystyrene blocks may be used instead of wood blocking between the joists

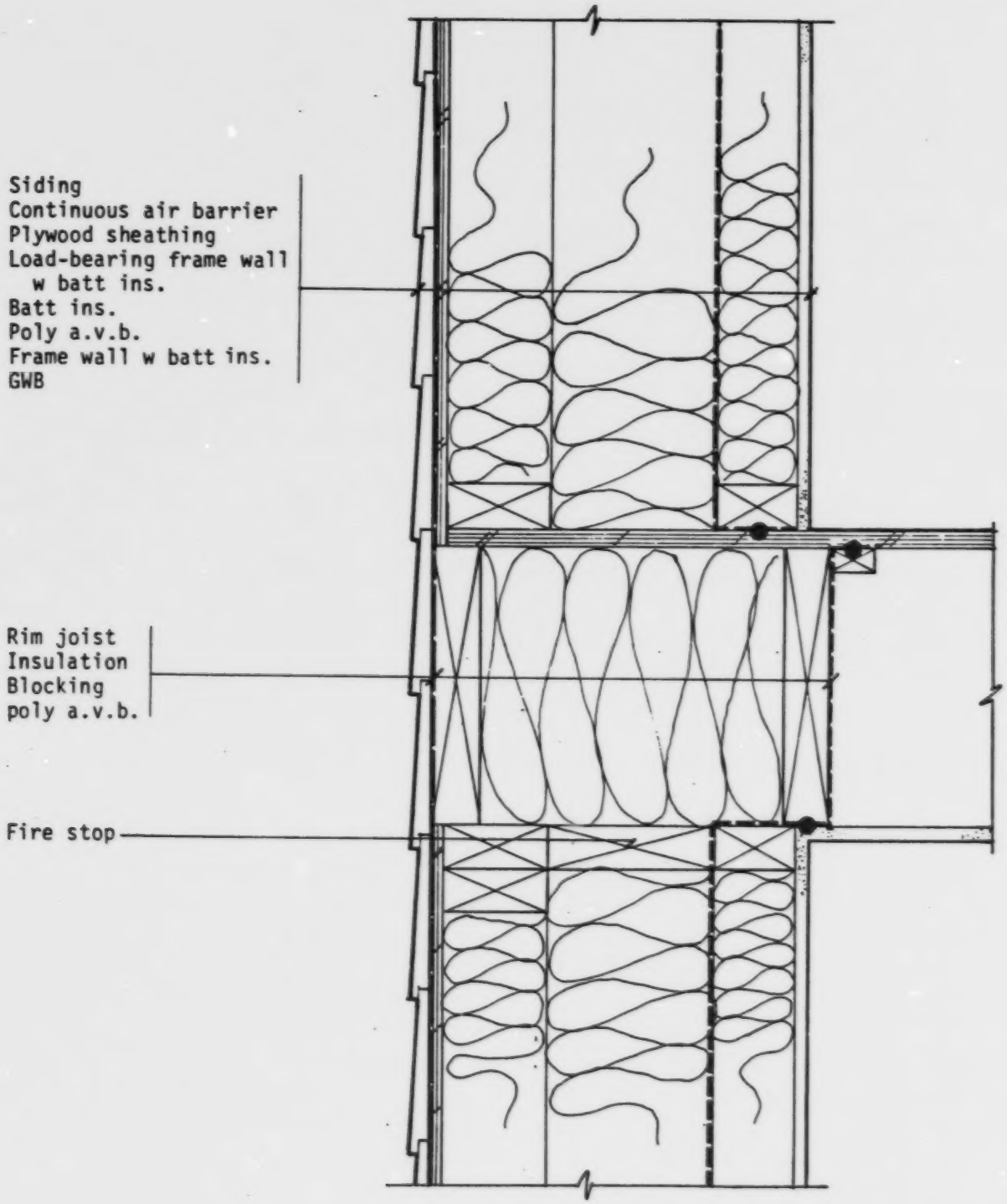




AGW	BGW	RF	I		DATE	SCALE	DRWG #
54	--	--	06		12/84	1:5	64

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
54	--	--	06		12/84	1:5	64

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

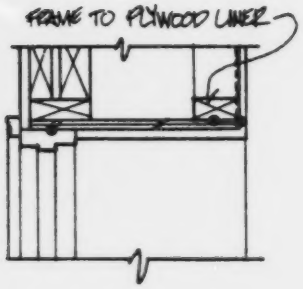
WINDOW HEAD DETAIL IN DOUBLE FRAME WALL, EXTERIOR WALL LOADBEARING

The rough window opening is lined with plywood prior to installation of the window. Rough framing tolerances are low and the use of multiple caulked joints between plywood and framing is prone to error and corner leakage. In this wall variation the plywood air-vapour barrier is located on the outer surface of the inner stud.

Technical Performance:

- must be correctly installed to perform well.

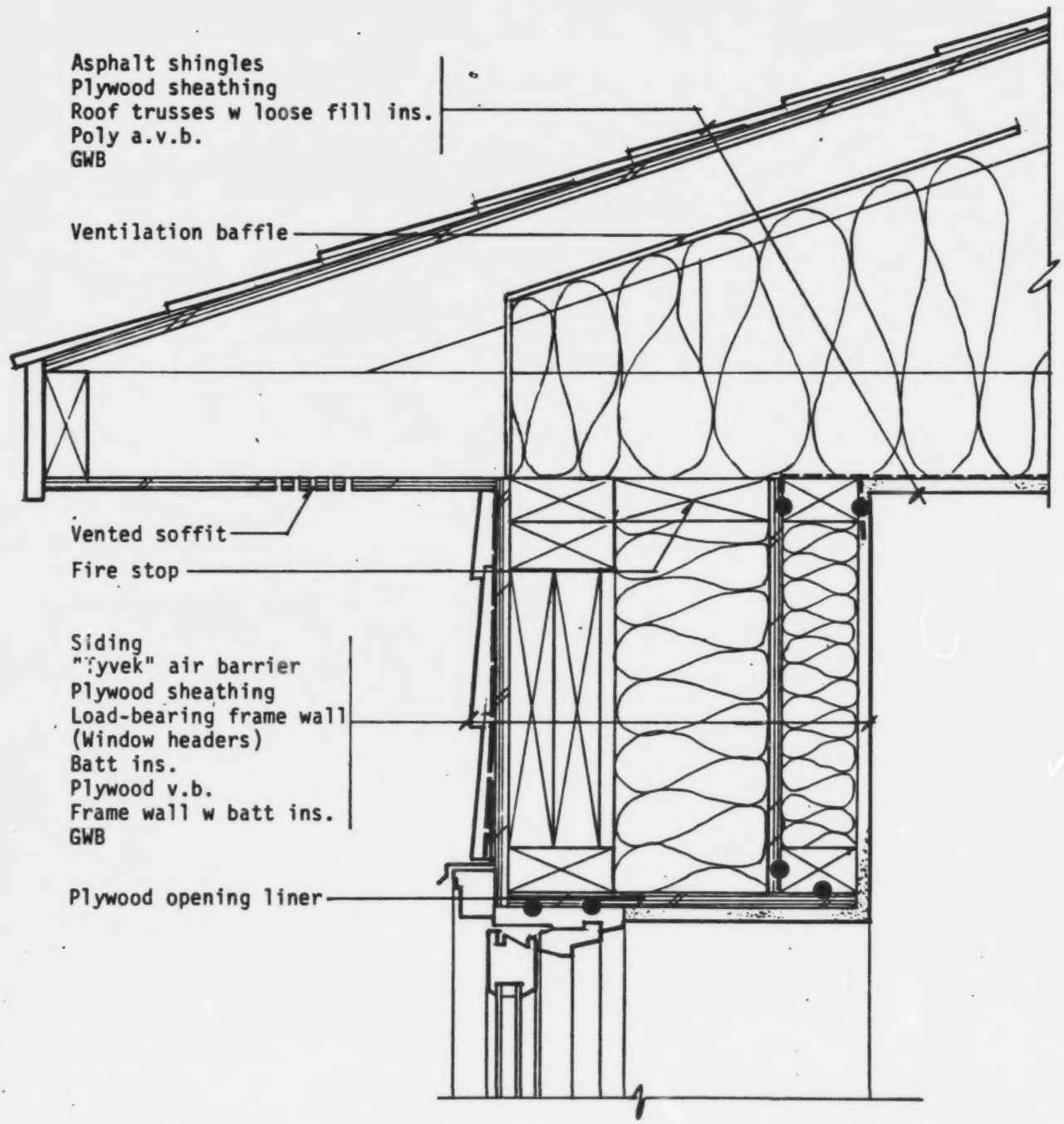
Practical Application:



- it is more practical to mount the air-vapour barrier immediately behind the drywall and seal all service penetrations
- plywood window boxes may be fitted with corners caulked in outer framing and interior wall framed and caulked in around them
- if windows can be installed prior to interior wall framing the plywood liner may be attached to the window rather than the rough stud opening and the polyethylene air-vapour barrier subsequently caulked to the plywood
- foamed in place polyurethane may be used to fill any gaps between window frame and plywood liner

AGW	BGW	RF	I		DATE	SCALE	DRWG #
54	--	31	22		12/84	1:5	65

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
54	--	31	22		12/84	1:5	65

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

THICK WALL - STANDOFF SYSTEMS

Wall systems in which the thickness can be increased at will are referred to as thick wall systems. For consistency, all thick wall systems in this document have been drawn at 300 mm with a nominal R value of R 7. However, nominal values may range from about R 5 to R 10. Standoff systems consist of a conventional wall frame with standard sheathing in which the air-vapour barrier is located on the outside of the frame. A lightweight non bearing frame is then attached to the exterior of the wall to create a cavity for insulation. The system is suitable for both new housing and retrofit applications.

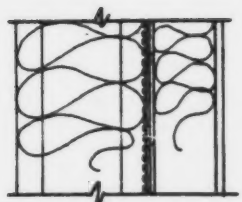
The following section documents three standoff variations:

AGW 61 drawings show a manufactured standoff truss.

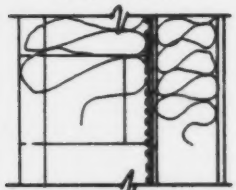
AGW 62 drawings show a site built standoff system.

AGW 63 drawings show a site built method which uses pre-manufactured sheet metal channels and provides horizontal support for siding.

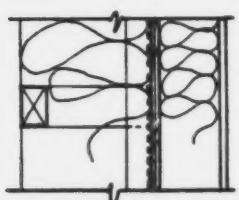
A full building section is provided for AGW 61.



AGW 61



AGW 62



AGW 63

Observations:

1. If the air-vapour barrier is polyethylene it should be an ultra violet stabilized type since it is exposed during the construction process.

2. The air-vapour barrier must remain above dew point temperatures which means, normally that at least two thirds of the total R value of the wall must be placed on the outside of the air-vapour barrier. The standoff cavity is therefore sized to be at least twice the depth of the studs.

BUILDING SYSTEM USING MANUFACTURED STANDOFF TRUSSES OVER CONVENTIONAL 38 X 89 MM FRAME ON CONCRETE FOUNDATION

The building section shown illustrates the following combination of systems:

Concrete foundation with exterior insulation
Prefabricated wall truss over conventional 38 x 89 mm frame wall
Raised heel standard truss

The wall section consists of conventional platform frame construction with the external addition of the prefabricated trusses. The system allows for nominal insulation levels up to RSI 7, and, as detailed, allows for the installation of a continuous air-vapour barrier. As the system acts as a blanket to the entire structural frame of the building, thermal bridging is greatly minimized.

Nominal RSI: 7.0 Modified RSI: 6.53

System Advantages:

- framing of structural element of house follows conventional practices,
- electrical and plumbing runs can be conventionally installed without damaging air-vapour barrier
- air-vapour barrier installation is continuous from soffit to foundation wall
- installation time and requirements for sealing of air-vapour barrier are reduced

System Disadvantages:

- to eliminate convective loops within the truss cavities, special measures must be taken to fill all space with insulation
- methods will require use of u.v. stabilized polyethylene
- on multiple story buildings additional scaffold work will be required
- a mixing of cross grain and parallel grain lumber could result in significant differential movement between the inside and outside walls
- system installation is weather dependent.

All AGW 61 drawings describe this wall type.

DRAWING #

			67
	69	68	
			70
		71	
			72

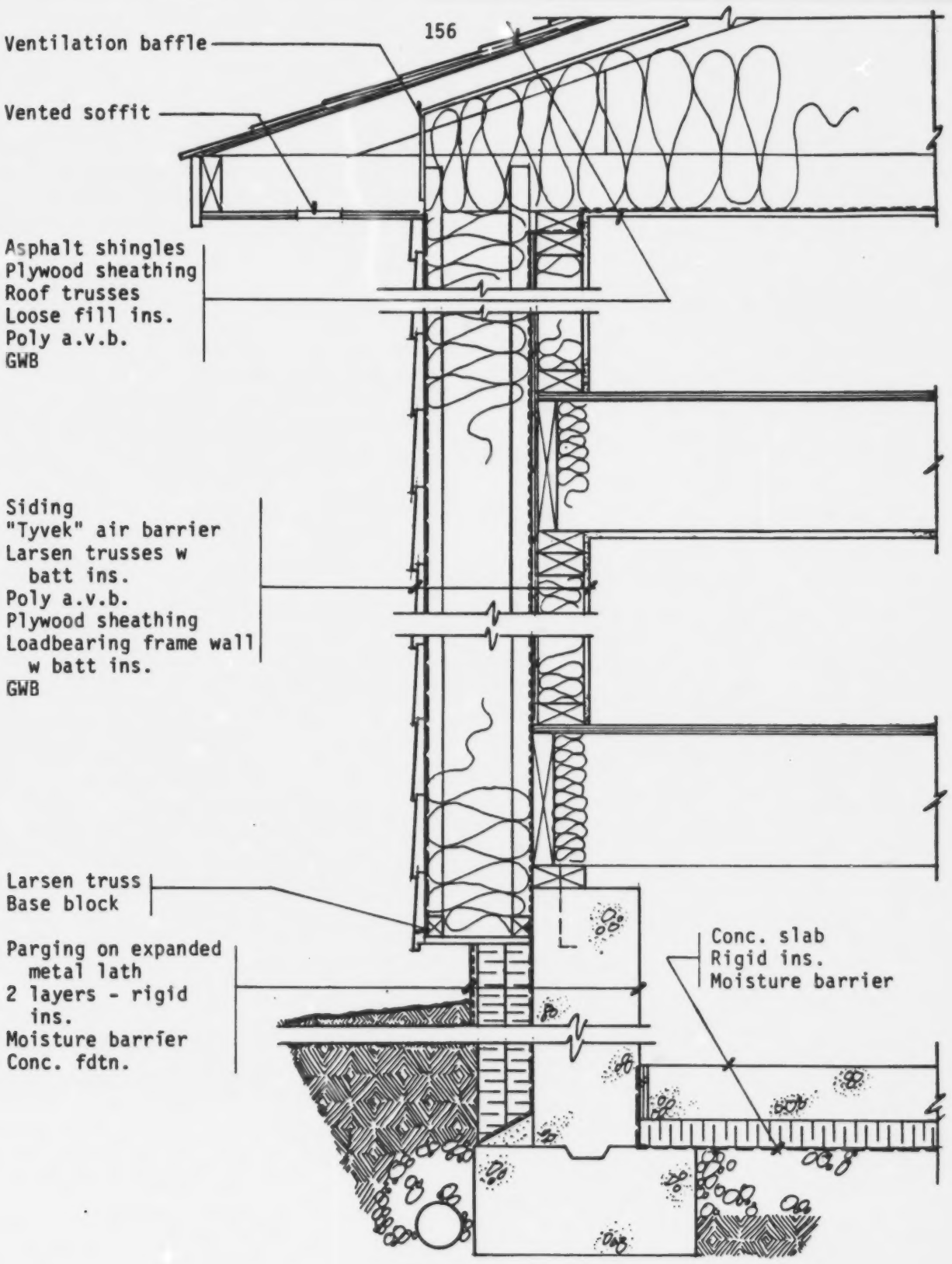
KEY DETAILS

PLAN OF WALL
FOOTING
SILL
INTERMEDIATE FLOOR
WINDOW
EAVE

Refer also to the sections on roofs, openings and penetrations for other applicable details

AGW	BGW	RF	I		DATE	SCALE	DRWG #
61	21	31	--		12/84	1:10	66

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
. 61	21	31	--		12/84	1:10	66

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

STANDOFF SYSTEM USING MANUFACTURED COMPONENTS

This plan view of a standoff system demonstrates framing techniques at interior and exterior corners. To provide support for standoffs which are not over interior studs, horizontal blocking must be nailed between interior studs. Corner standoffs are supported by horizontal corner trusses.

Technical Performance:

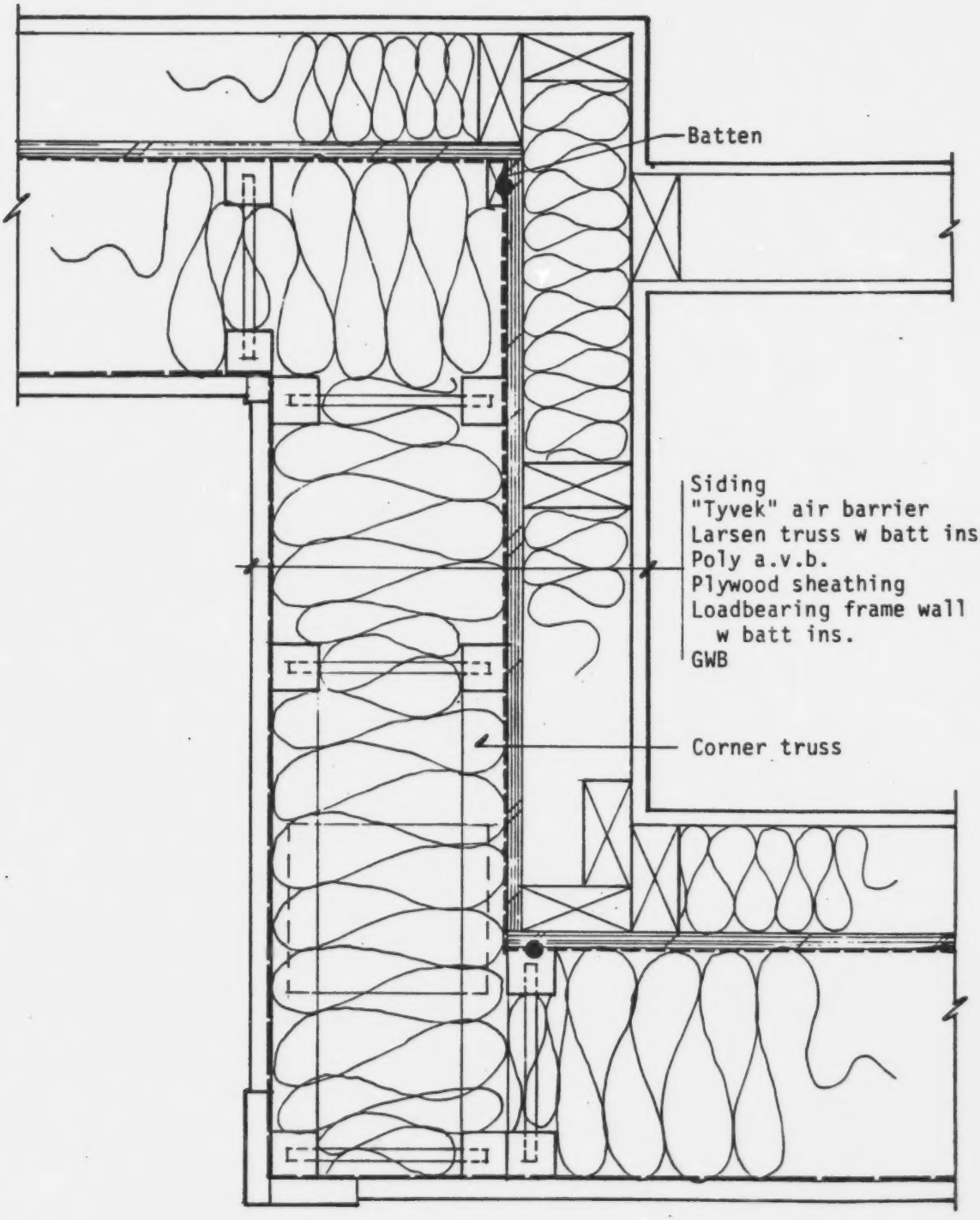
- allows for effective air-vapour barrier installation without interruptions. Mechanical fastening over seams ensures integrity of air-vapour barrier.
- the system allows for high insulation levels
- risk of convective air movement in the truss cavity
- air-vapour barrier should be u.v. stabilized polyethylene as it will be exposed over several days
- joints in air-vapour barrier must be supported by battens

Practical Application:

- sourcing of extra wide batt insulation may prove difficult. The use of standard width batts would lead to a major decrease in system efficiency if they were installed vertically. Standard width batts may be installed horizontally
- sourcing of u.v. stabilized polyethylene may prove difficult and is more expensive than standard polyethylene
- air-vapour barrier installation can be easily inspected for continuity and any damage can be easily repaired prior to insulation

AGW	BGW	RF	I		DATE	SCALE	DRWG#
61	--	--	07		12/84	1:5	67

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
61	--	--	07		12/84	1:5	67

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

SILL DETAIL, MANUFACTURED STANDOFF SYSTEM ON EXTERNALLY INSULATED CONCRETE FOUNDATION

This detail illustrates a standoff truss assembly mounted on a conventional frame resting on an externally insulated masonry foundation.

Technical Performance:

- if air-vapour barrier is extended to footings this detail shows the potential for good airtightness
- insulation levels over foundation wall are less than optimum with thermal bridging occurring at the base of the standoffs
- batt insulation could be fitted between floor joists
- the detail allows for some differential movement between the inner structure and the truss assembly
- u.v. stabilized polyethylene should be used

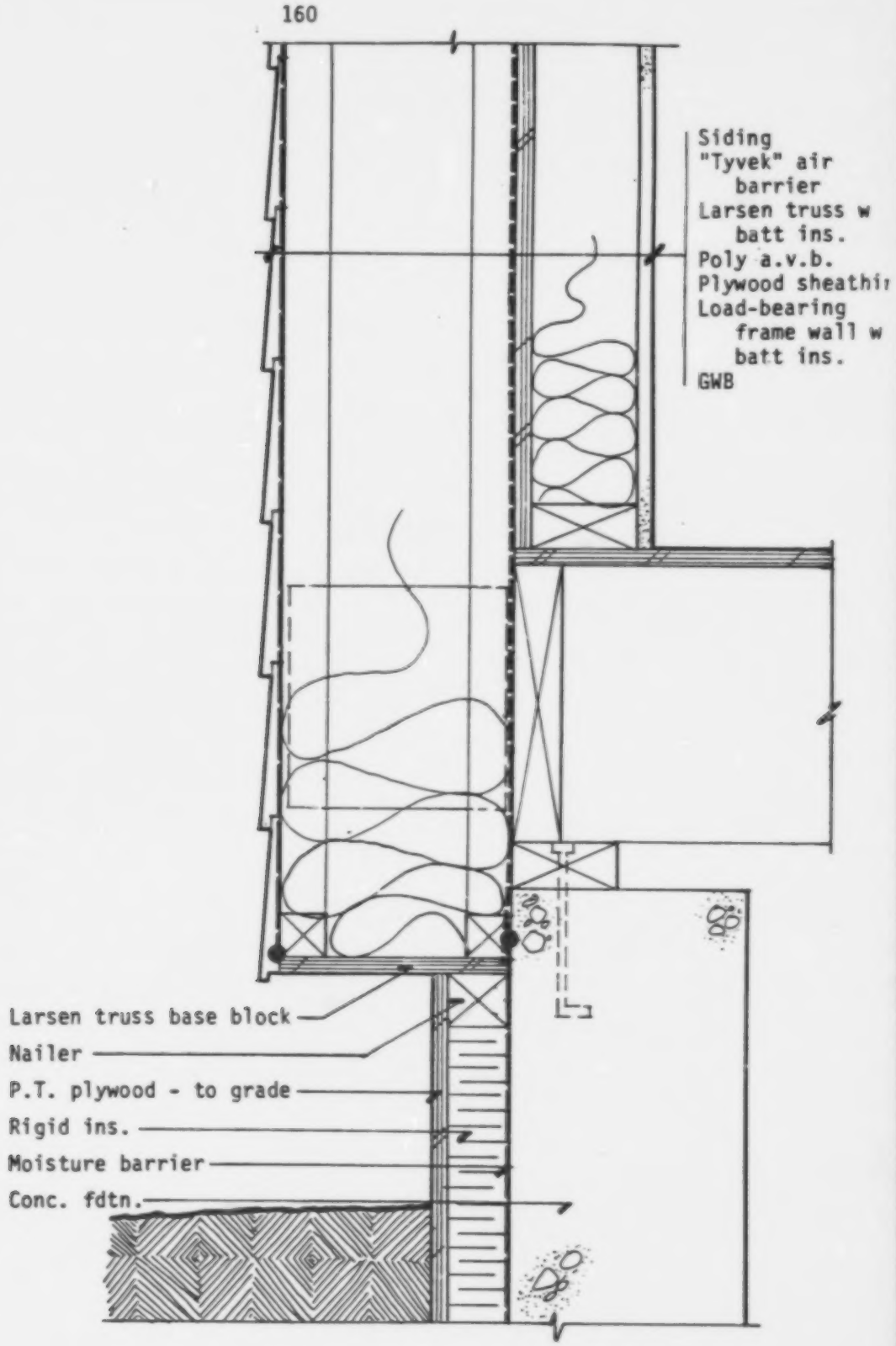
Practical Application:

- base block system shown permits excessive heat loss and potential for condensation damage at the sill. An alternative method should be selected
- two layers of below grade insulation could be installed
- installation of air-vapour barrier and insulation is weather dependent
- wide batts should be used between the standoffs or batts may be installed horizontally to ensure a tight fit

AGW	BGW	RF	I		DATE	SCALE	DRWG
61	21	--	01		12/84	1:5	68

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

160



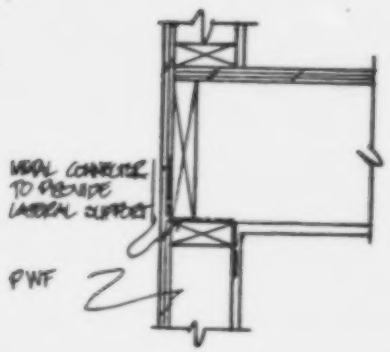
AGW	BGW	RF	I		DATE	SCALE	DRWG#
61	21	--	01		12/84	1:5	68

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

SILL DETAIL, STANDOFF WALL SYSTEM ON PRESERVED WOOD FOUNDATION

This detail illustrates conventional 38 x 89 platform frame construction on a preserved wood foundation with a manufactured standard truss system.

Technical Performance:



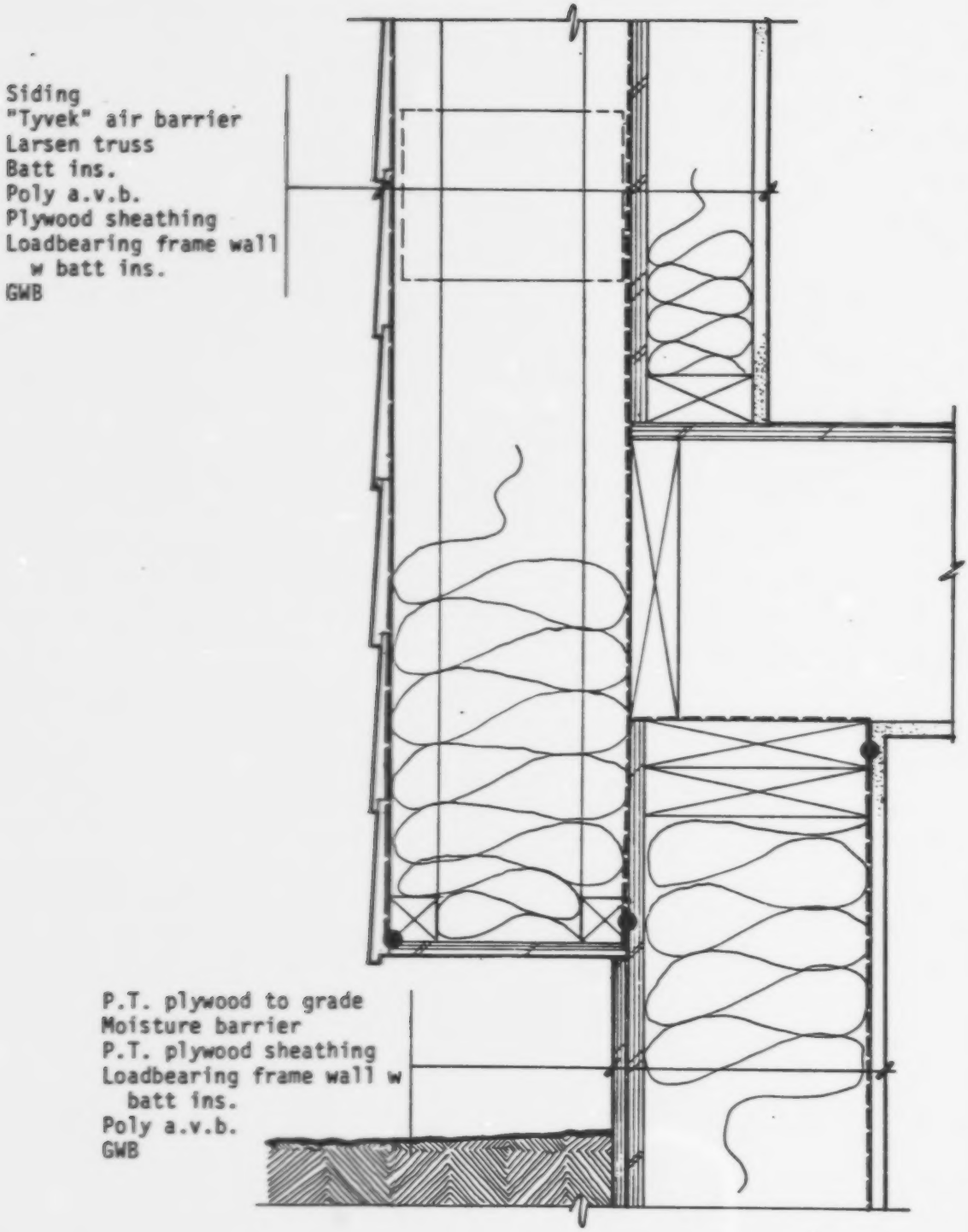
- detail shows good airtightness potential and allowance for good insulation levels
- as drawn a vapour lock situation would exist on the above grade section of the PWF
- the detail allows for some differential movement between the inner structure and the truss assembly
- additional insulation could be installed at header
- as drawn the system requires special fasteners as per CSA 5406

Practical Application:

- sourcing of both PWF and required connectors is difficult in some areas of the country
- prefabricated trusses may be difficult to source although they can be easily manufactured or site-built
- installation of air-vapour barrier and insulation in truss cavities is weather dependent

AGW	BGW	RF	I		DATE	SCALE	DRWG #
61	29	--	01		12/84	1:5	69

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
61	29	--	01		12/84	1:5	69

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

INTERMEDIATE FLOOR JUNCTION WITH STANDOFF WALL SYSTEM

This detail illustrates the use of a prefabricated standoff truss mounted on a conventionally framed 38 x 89 structural wall.

Technical Performance:

- minimized thermal bridging across wall assembly
- good airtightness levels are permitted
- joints in the polyethylene must be supported by battens
- u.v. stabilized polyethylene should be used

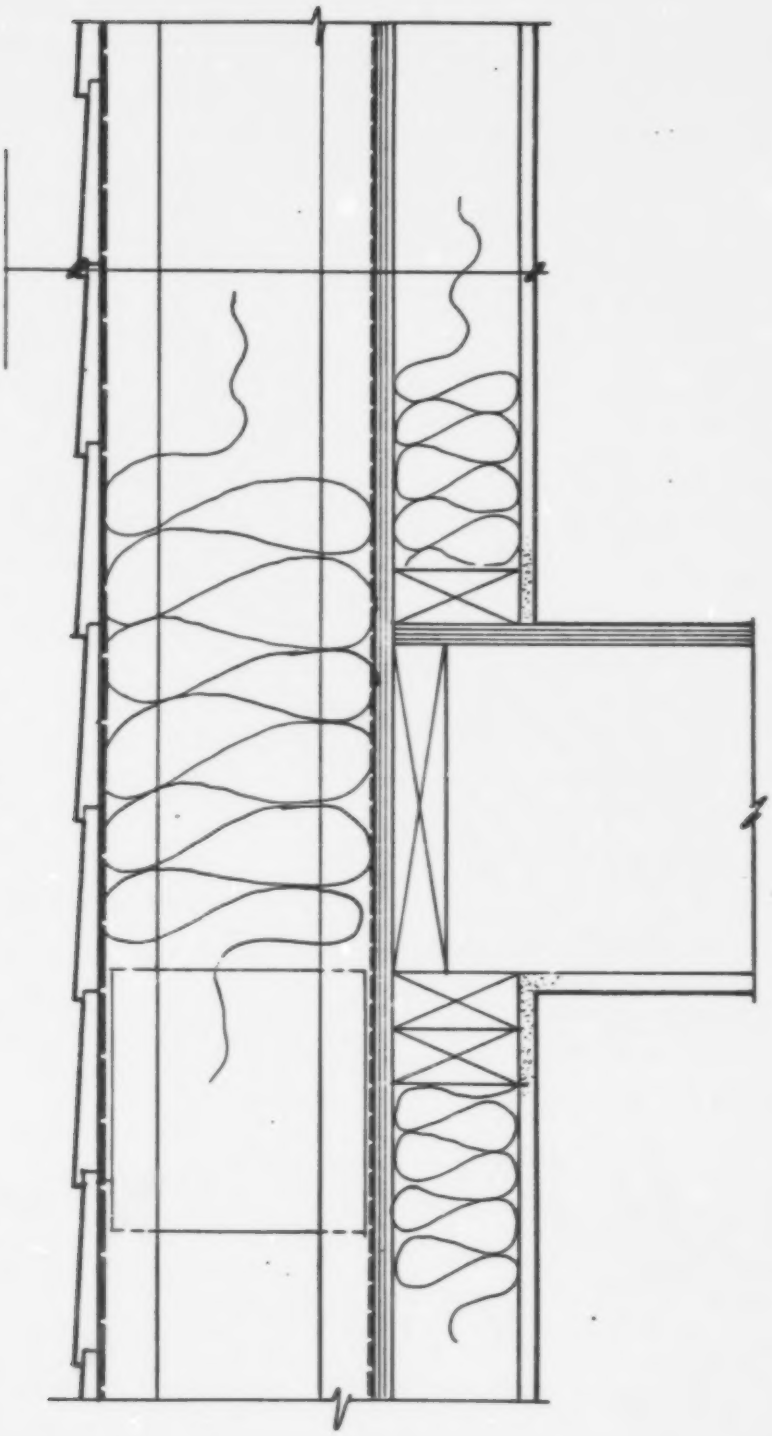
Practical Application:

- trusses are nailed into top plates, into nailers at the mid sections and into the joist headers
- installation and inspection of the air-vapour barrier can be easily performed from the exterior prior to insulation

AGW	BGW	RF	I		DATE	SCALE	DRWG#
61	--	--	06		12/84	1:5	70

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

Siding
"Tyvek" air barrier
Larsen truss w batt ins.
Poly a.v.b.
Plywood sheathing
Loadbearing frame wall w batt ins.
GWB



AGW	BGW	RF	I		DATE	SCALE	DRWG#
61	--	--	06		12/84	1:5	70

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

WINDOW DETAIL, IN MANUFACTURED STANDOFF SYSTEM

This detail illustrates the use of plywood to box the interior of a window opening spanning a truss wall system.

Technical Performance:

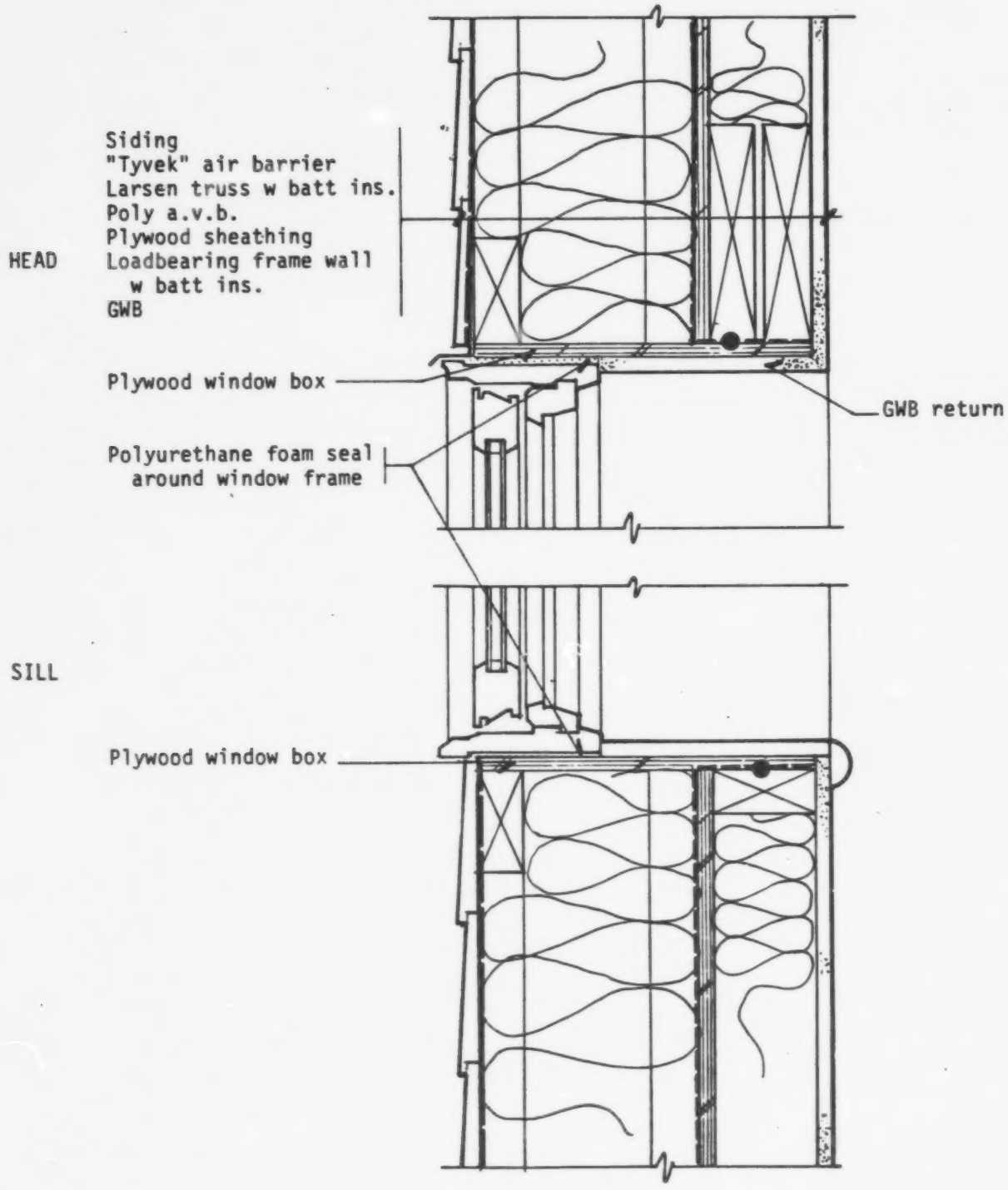
- the plywood window liners will provide structural rigidity to a truss wall system
- as drawn the outer chord of the wall truss carries the weight of the windows. Additional framing materials will be required
- caulking between window and plywood liner must fill all voids. If polyurethane foam is used it may shrink over time resulting in air leakage around the windows

Practical Application:

- rough stud openings will need to be larger than normal to accommodate the plywood liner. The plywood should be cut to span the entire opening
- foamed in place polyurethane or polyethylene foam may be used to fill the gap between the window and the plywood liner

AGW	BGW	RF	I		DATE	SCALE	DRWG*
61	--	--	22		12/84	1:5	71

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
61	--	--	22		12/84	1:5	71

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

EAVE DETAIL, RAISED HEEL TRUSS ON MANUFACTURED STANDOFF

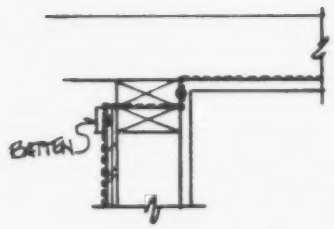
This detail illustrates the junction of the wall truss and the ceiling truss. As drawn the system shows the wall truss nailed to the bottom chord of the roof truss. When combined with a flexible base detail this system should not experience major trouble. If however the outer wall was firmly fixed at the base, major differential movement might result in the truss wall carrying the roof load.

Technical Performance:

- potential for truss wall to bear roof load if base assembly is not reasonably flexible

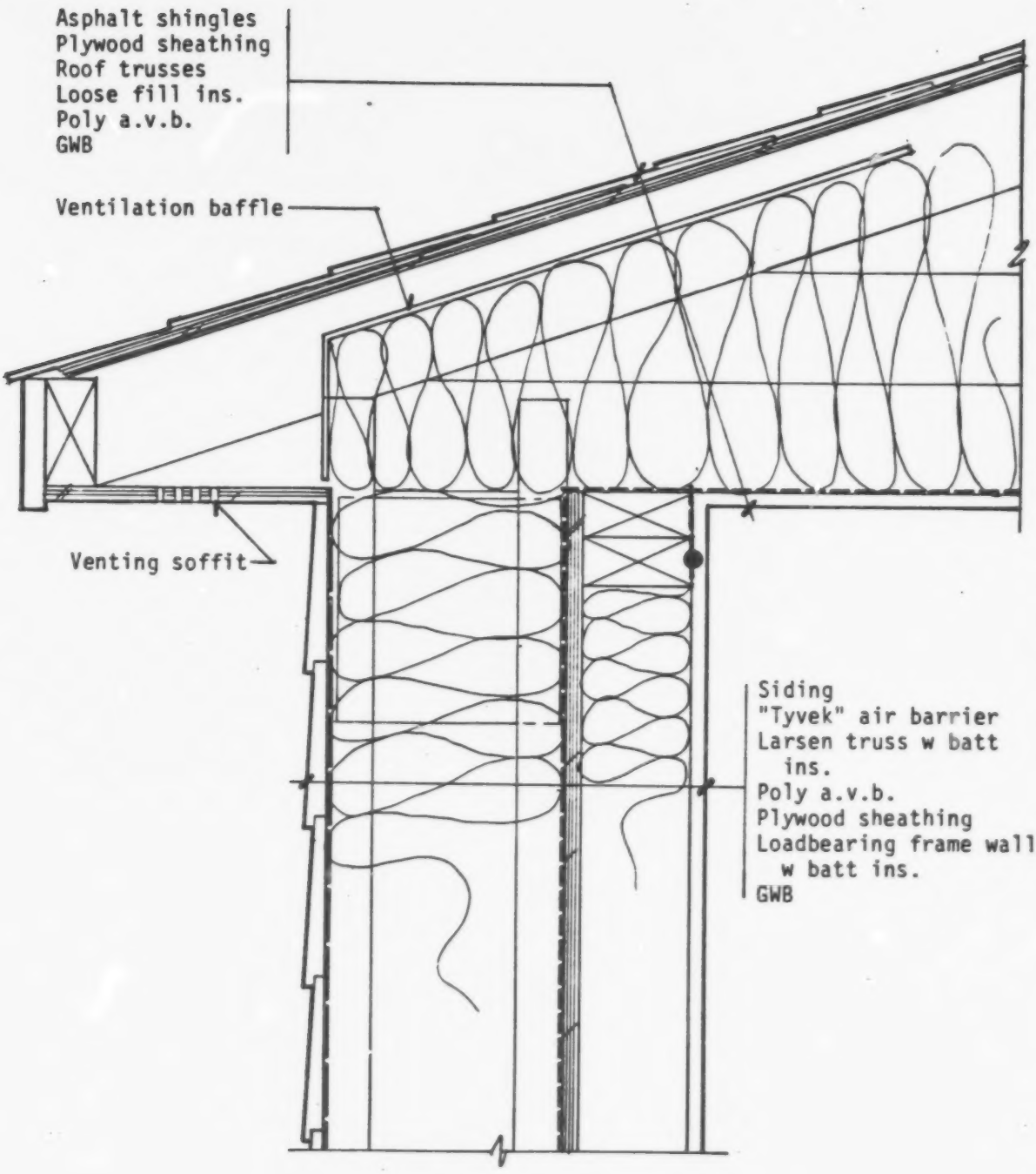
Practical Application:

- as drawn the wall air-vapour barrier must be installed before the roof truss. An alternate approach would involve installing a strip of polyethylene between the top plates of the interior wall. This strip would then be sealed to the ceiling air-vapour barrier and to the air-vapour barrier on the walls. This system also protects the air-vapour barrier from damage during installation of truss



AGW	BGW	RF	I		DATE	SCALE	DRWG#
61	--	31	10		12/84	1:5	72

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
61	--	31	10		12/84	1:5	72

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

PLAN OF STANDOFF VARIATION USING SITE-ASSEMBLED COMPONENTS

In this detail the standoffs are site built and consist of short blocks of 38 x 89 nailed to plywood gussets. Claimed advantages are flexibility in location and depth of standoffs. Disadvantages include requirement for solid support for blocking and unknown structural limitations. As with other standoff systems this type is weather dependent and has difficult window and door detailing.

Technical Performance:

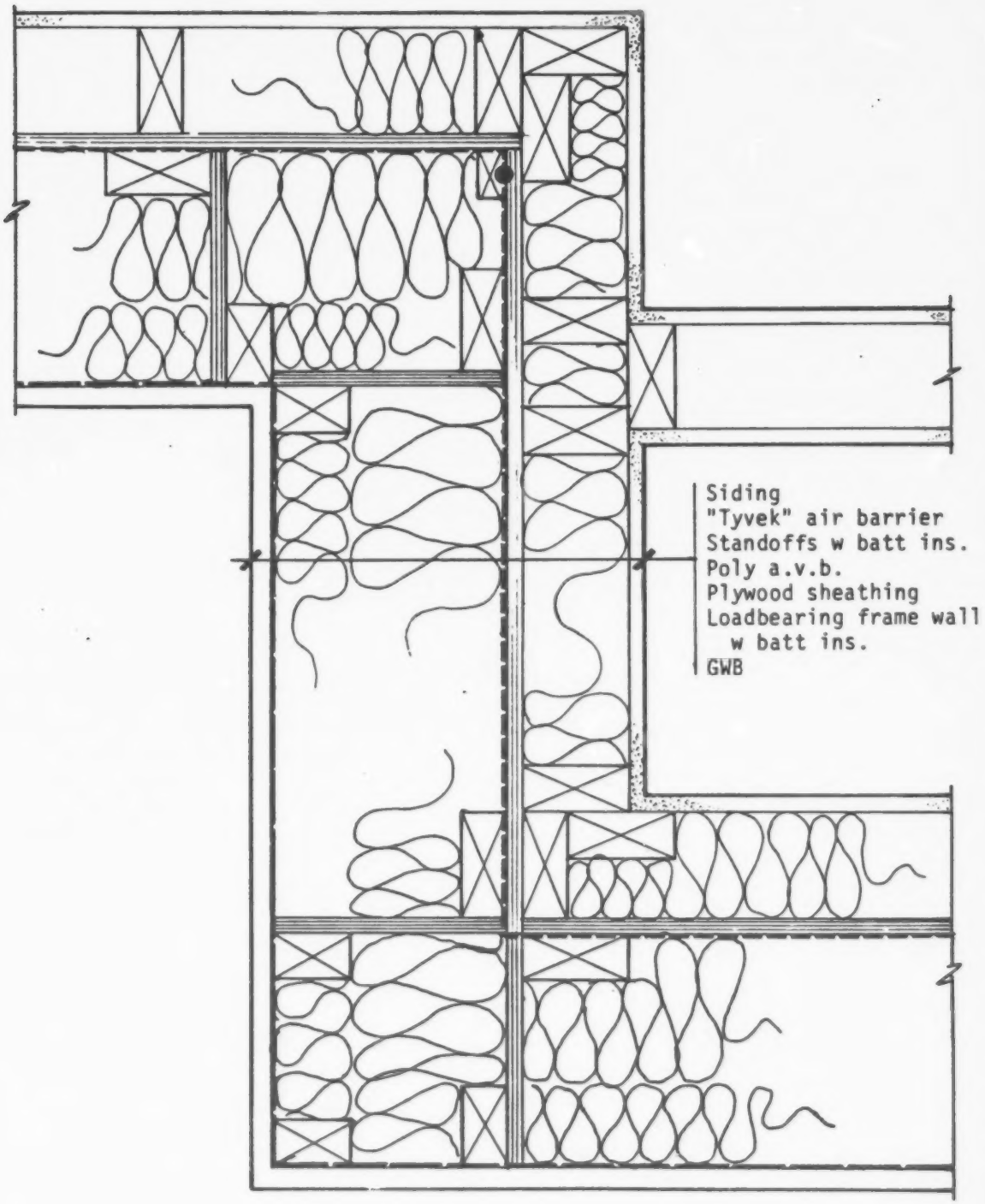
- blocks must be securely fastened to existing structure
- outer stud must be either supported from below or hung from above
- polyethylene must be u.v. stabilized
- joints in polyethylene should be supported by battens

Practical Application:

- studs may be nailed to rafter tails and standoff blocks fastened securely to top plates and rim joists
- if studs are not located directly under rafters horizontal nailers may be required for intermediate support

AGW	BGW	RF	I		DATE	SCALE	DRWG #
62	--	--	07		12/84	1:5	73

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG #
62	--	--	07		12/84	1:5	73

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

SILL DETAIL, STANDOFF VARIATION ON CONCRETE FOUNDATION WITH EXTERIOR INSULATION

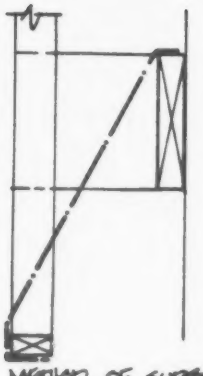
This detail shows the same site built standoff system shown in the previous drawing. Standoffs consist of a block of 38 x 89 fastened to a plywood gusset plate supporting a vertical 38 x 64 stud.

Technical Performance:

- the outer stud must be supported, either from above by nailing to the rafter, or from below
- installation of batts in two layers in standoff cavity as shown reduces risk of gaps in the insulation and convection losses
- polyethylene should be u.v. stabilized

Practical Application:

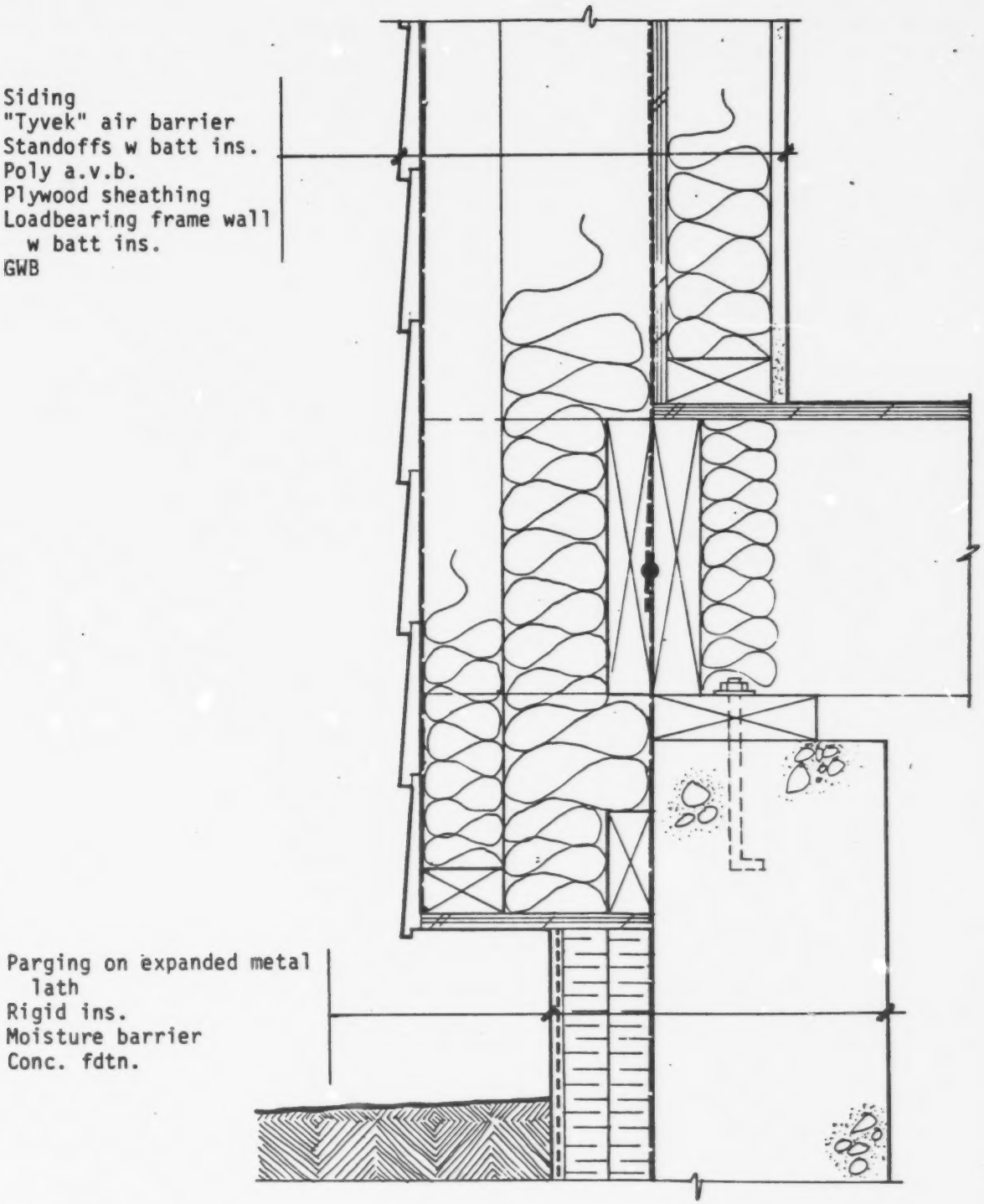
- care is needed in locating standoff blocks over solid support



METHOD OF SUPPORT USING METAL STRAP

AGW	BGW	RF	I		DATE	SCALE	DRWG
62	21	--	01		12/84	1:5	74

Drawn for CMHC under File no. 6350-18 by ALLEN-DRUP-WHITE LTD., to be used for documentary purposes only.



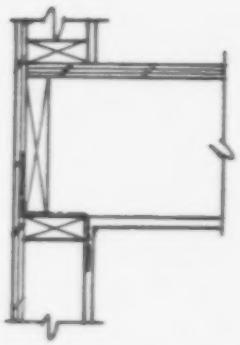
AGW	BGW	RF	I		DATE	SCALE	DRWG#
62	21	--	01		12/84	1:5	74

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

SILL DETAIL, STANDOFF VARIATION ON A DOUBLE FRAME PRESERVED WOOD FOUNDATION

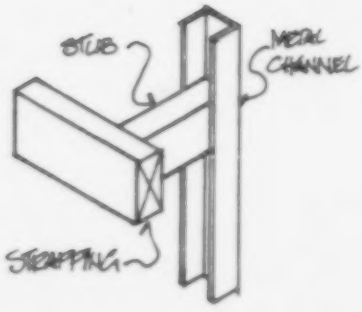
This detail shows a double frame foundation system used with a site-assembled standoff system. The standoffs consist of a galvanized metal U channel with 38 x 64 mm stubs nailed to it. Horizontal 38 x 64 mm strapping is fastened to the stubs after the channels have been secured to the wall.

Technical Performance:



- depending on backfill conditions, a metal strap is required to fasten joist to top plate of wall to resist lateral soil pressures
- loose insulation is shown in the above grade standoff wall cavity. Provision must be made to 'top up' the insulation from time to time should it be subject to settling
- below grade outer wall cavity shows single batt and 140 mm stud; 89 mm stud and two batts would be preferable
- u.v. stabilized polyethylene must be used
- all joints in the polyethylene must be supported with battens

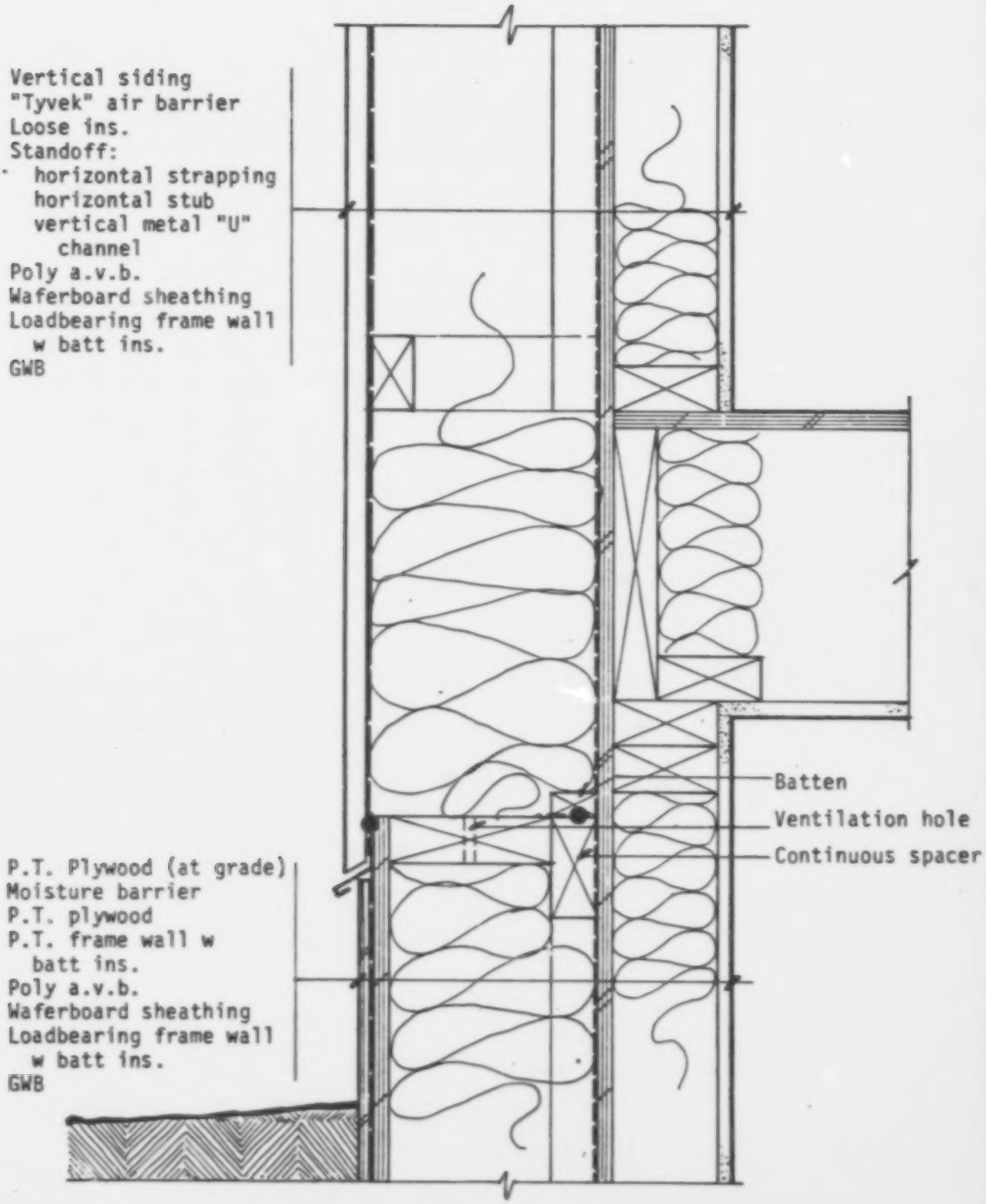
Practical Application:



- system is similar in application to the Larsen truss except that vertical rather than horizontal siding must be used
- U channels are prefabricated in a sheet metal shop and the stubs nailed in place on site

AGW	BGW	RF	I		DATE	SCALE	DRWG#
63	26	--	01		12/84	1:5	75

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
63	26	--	01		12/84	1:5	75

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

THICK WALL - EXPANDED STUD SYSTEMS

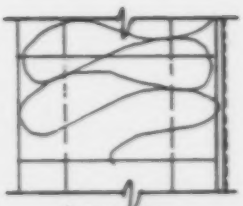
The final thick wall type documented in this report is the expanded stud system in which manufactured or site built vertical trusses replace conventional wall studs. All thick wall systems have been drawn at 300 mm with a nominal R value of R 7. However, nominal values may range from about R 5 to R 10.

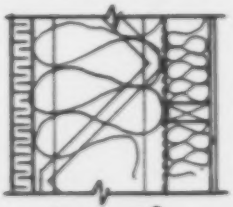
The following section documents two expanded stud variations:

AGW 71 drawings show a manufactured truss with plywood gusset plates.

AGW 72 drawings show a manufactured truss with metal webs.

A full building section is provided for AGW 71.





Observations:

1. Manufactured trusses have inherent economy of materials and provide deep wall cavities however some characteristics of wall trusses may reduce effective R value of installed insulation.

2. The air-vapour barrier must be applied on the inside surface of the wall truss, normally immediately behind the drywall. Trade training and supervision will be required to ensure a adequate sealing.

BUILDING SYSTEM USING EXPANDED STUDS, TRUSS FLOOR JOISTS AND EXPANDED RAFTERS ON A PRESERVED WOOD GRADE BEAM

This section illustrates a building designed for Arctic weather conditions. The section incorporates the following features:

- expanded stud walls, modified balloon frame
- expanded rafters gussetted directly to the wall trusses
- truss floors incorporating high insulation

The section demonstrates some innovative approaches to incorporating high insulation levels in northern housing where the harsh climate requires many alterations to standard construction practices. The use of expanded stud walls and rafters allows high insulation levels to be incorporated into the building envelope and the system was designed for rapid erection and close in.

Nominal RSI: 7.0 Modified RSI: 7.22

System Advantages:

- allows for considerable prefabrication of components and reduced on-site labour
- air-vapour barrier is mechanically sandwiched between two rigid materials on the warm side of the envelope
- allows for high insulation levels with minimal framing requirements

System Disadvantages:

- requires additional care for sealing of electricals and plumbing runs which penetrate the air-vapour barrier
- the air-vapour barrier could be unintentionally damaged by homeowners - hanging pictures, cupboards, etc.
- sub floor at grade level can not be nailed until insulation is installed. House must be made watertight before insulating floors
- as roof is not ventilated, air-vapour barrier must be exceptionally well installed
- framing elements require mechanical assistance for erection

All AGW 71 drawings describe this wall type.

DRAWING #

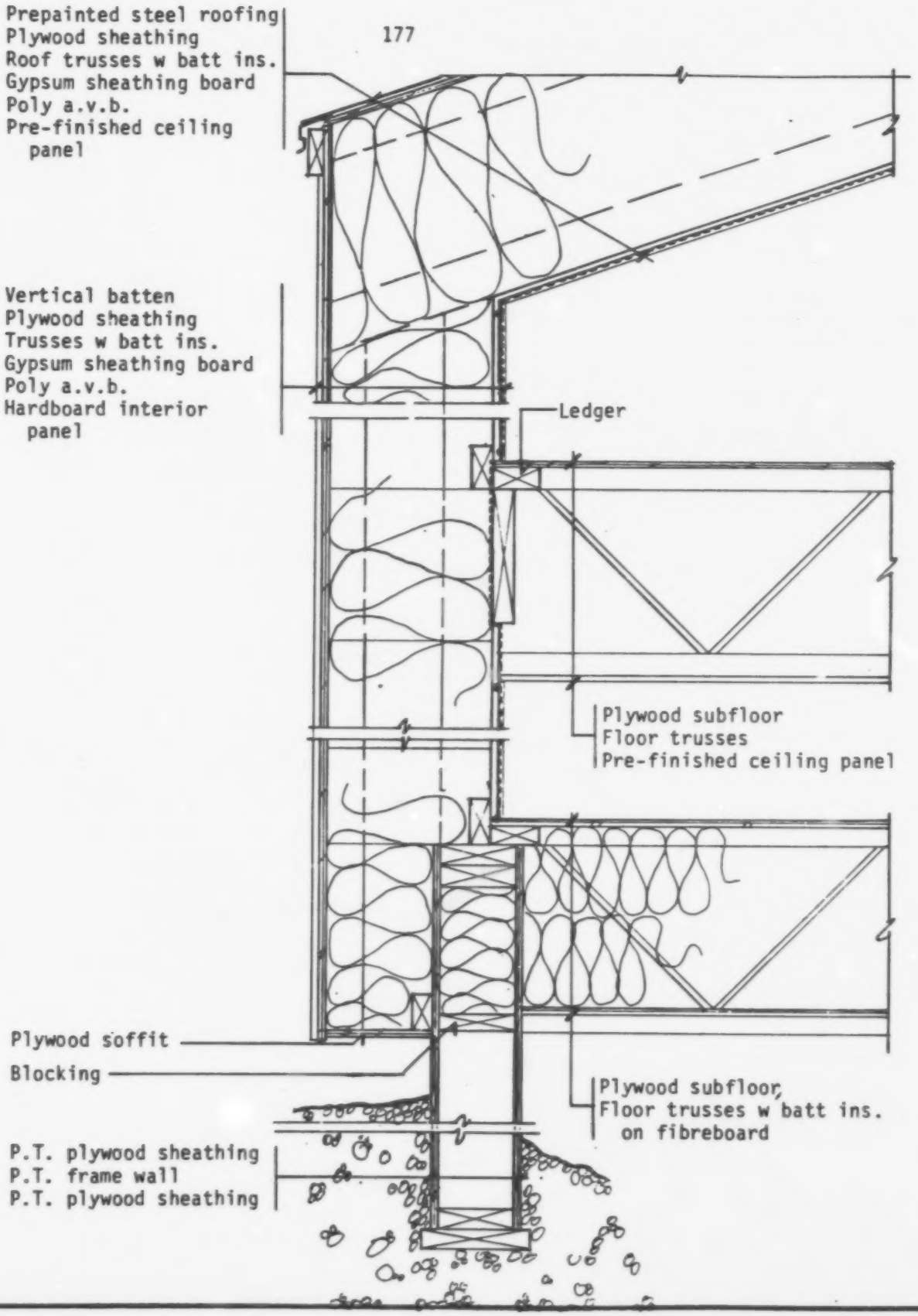
			77	PLAN OF WALL
				FOOTING
			78	SILL
			79	INTERMEDIATE FLOOR
				WINDOW
			80	EAVE

KEY DETAILS

Refer also to the sections on roofs, openings and penetrations for other applicable details

AGW	BGW	RF	I		DATE	SCALE	DRWG#
71	28	35	--		12/84	1:10	76

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
71	28	35	--		12/84	1:10	76

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

EXPANDED STUD WALL
PLAN VIEW

This detail illustrates exterior corner treatment employing expanded studs. Note the use of blocking to frame out the corner. The drawing shows the construction methods used in truss fabrication. 38 x 89 interior and, 38 x 64 exterior cord, 38 mm expanded polystyrene and 9 mm plywood gusset plates at 24" o.c.

Technical Considerations:

- system allows for high insulation levels with some thermal bridging at the gusset plates
- interior air-vapour barrier is sealed at seams with caulking and then mechanically sandwiched between the gypsum sheathing board and the interior hardboard panel
- because the thick wall cavity is undivided, there is the potential for for vertical convection cells to occur

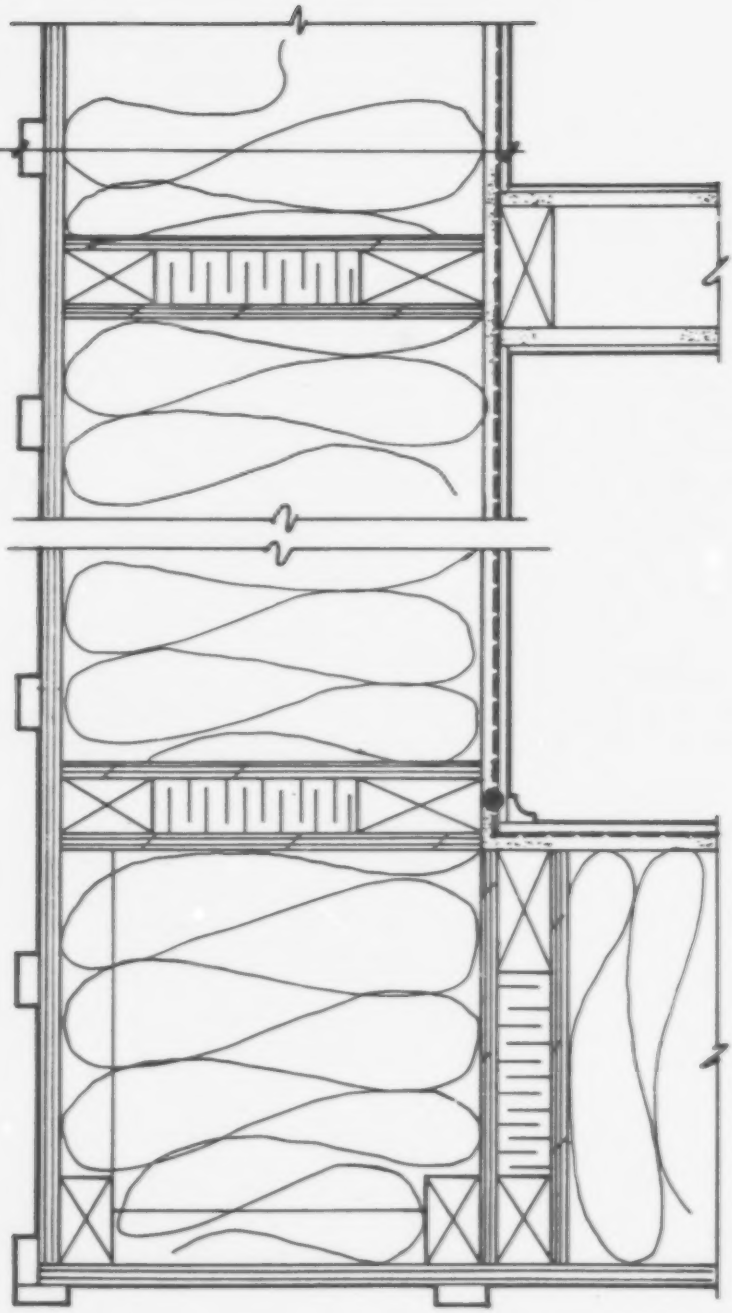
Practical Application:

- availability of pre-fabricated trusses will be limited, but they can be either manufactured or site built
- services (electrical and plumbing) can be conventionally installed provided that a good seal is maintained at the air-vapour barrier penetrations

AGW	BGW	RF	I		DATE	SCALE	DRWG#
71	--	--	07		12/84	1:5	77

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

Vertical battens
Plywood sheathing
Trusses w batt ins.
Gypsum sheathing board
Poly a.v.b.
Hardboard interior panel



AGW	BGW	RF	I		DATE	SCALE	DRWG#
71	--	--	07		12/84	1:5	77

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

INSULATED FLOOR TRUSSES OVER UNHEATED CRAWLSPACE

This detail illustrates an insulated truss floor and expanded stud wall located on a preserved wood grade beam. This system is designed for Arctic housing where unheated crawlspaces are a requirement. In this detail the floor truss is top chord bearing and the interior cord of the expanded stud wall is the bearing member.

Technical Considerations:

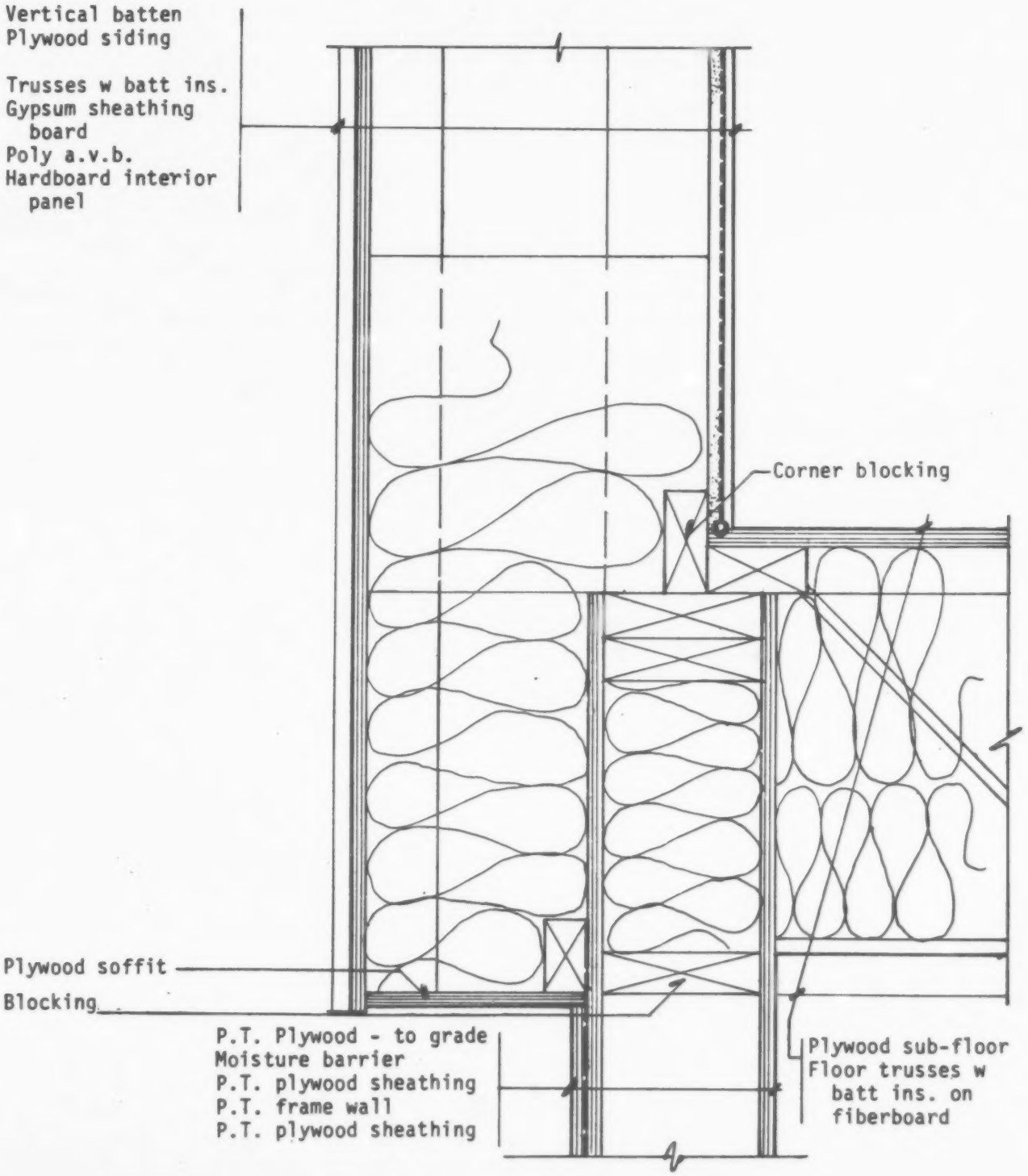
- system allows high levels of insulation, however, the potential for convective air movement with the insulated cavities is greater than for conventional assemblies

Practical Application:

- insulate floors only after the building has been made watertight

AGW	BGW	RF	I		DATE	SCALE	DRWG#
71	28	--	01		12/84	1:5	78

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
71	28	--	01		12/84	1:5	78

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

INTERMEDIATE FLOOR JUNCTION, EXPANDED STUD WALL AND FULLY INSET HEATER

This detail illustrates a system using an expanded stud wall and a modification of balloon framing to allow the installation of a continuous air-vapour barrier between floors.

Technical Considerations:

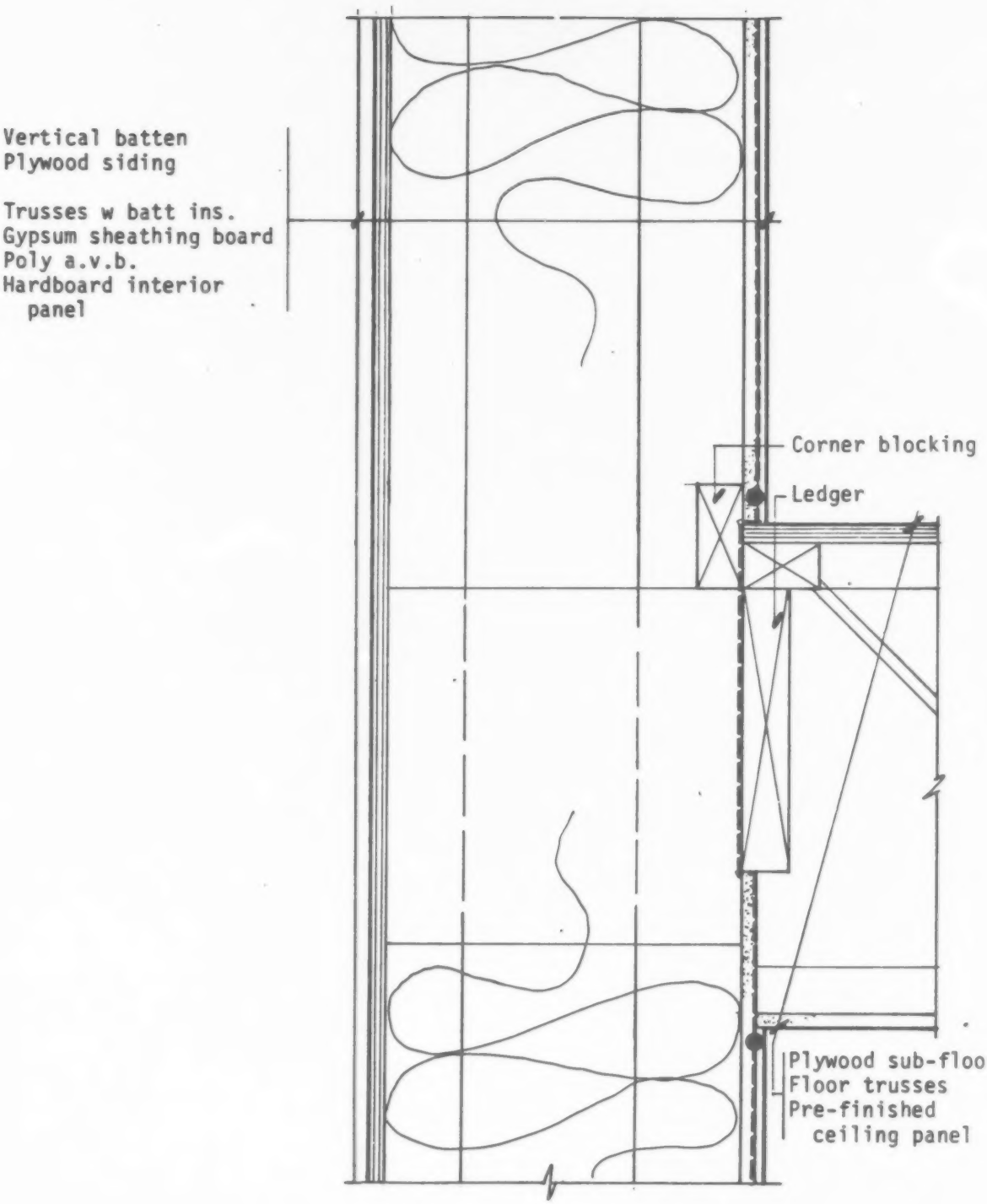
- fastening of the 38 x 120 ledger plate to the structural wall may require engineering
- the top cord of the floor truss is the bearing cord, adequate bearing must be provided
- system provides good thermal characteristics - high insulation levels and minimal thermal bridging

Practical Application:

- horizontal blocking provides a nailer for the base of the wallboard and a stop for the floor trusses
- system may be easier to construct if gypsum sheathing were extended continuously from floor to floor
- air-vapour barrier could be damaged during installation of floor trusses

AGW	BGW	RF	I		DATE	SCALE	DRWG#
71	--	--	06		12/84	1:5	79

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
71	--	--	06		12/84	1:5	79

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

UNVENTED EAVE DETAIL WITH EXPANDED STUD/RAFTER SYSTEM

This detail illustrates a system used in the Arctic where roof venting is not desirable. Wall and roof trusses are tied together by plywood gussets.

Technical Considerations:

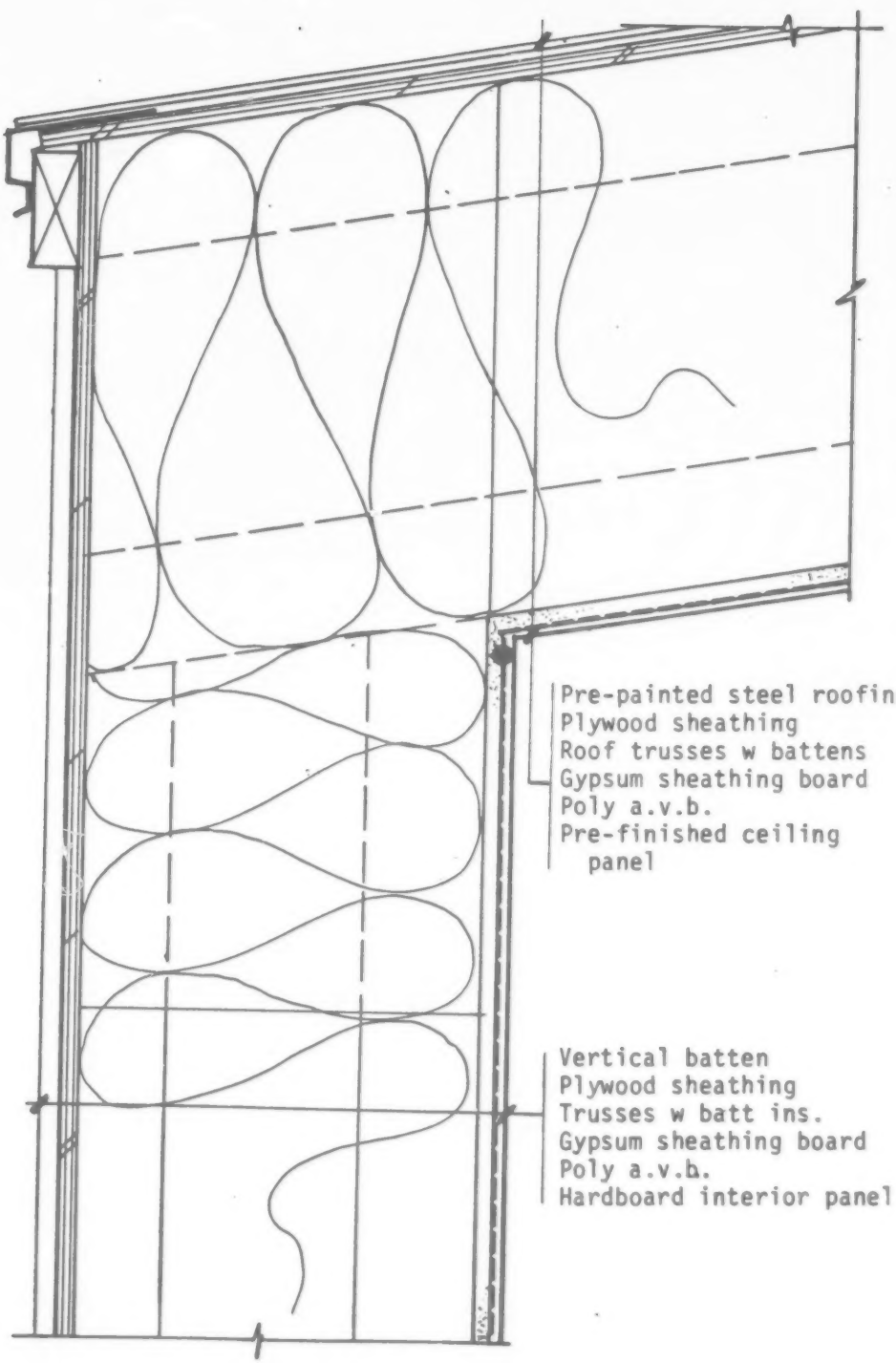
- lack of ventilation for roof assembly demands that air-vapour barrier be installed with no perforations or discontinuities
- for Arctic housing ventilation is discouraged to ensure that driven snow does not enter attic space

Practical Applications:

- wall and roof trusses are joined with plywood gusset plates on the ground and lifted into place as a continuous bent

AGW	BGW	RF	I		DATE	SCALE	DRWG#
71	--	35	10		12/84	1:5	80

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
71	--	35	10		12/84	1:5	80

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

PLAN VIEW OF EXPANDED STUD VARIATION

Prefabricated studs consist of parallel chord trusses with metal webs. In this system an entire wall is prefabricated on site and lifted into place. The system has the highest nominal R value of the submitted drawings but should be simplified to improve its practical application.

Technical Performance:

- some risk of convection cells occurring within the wall cavity
- metal web trusses could create thermal bridging problems if exterior insulating sheathing and interior strapping were eliminated

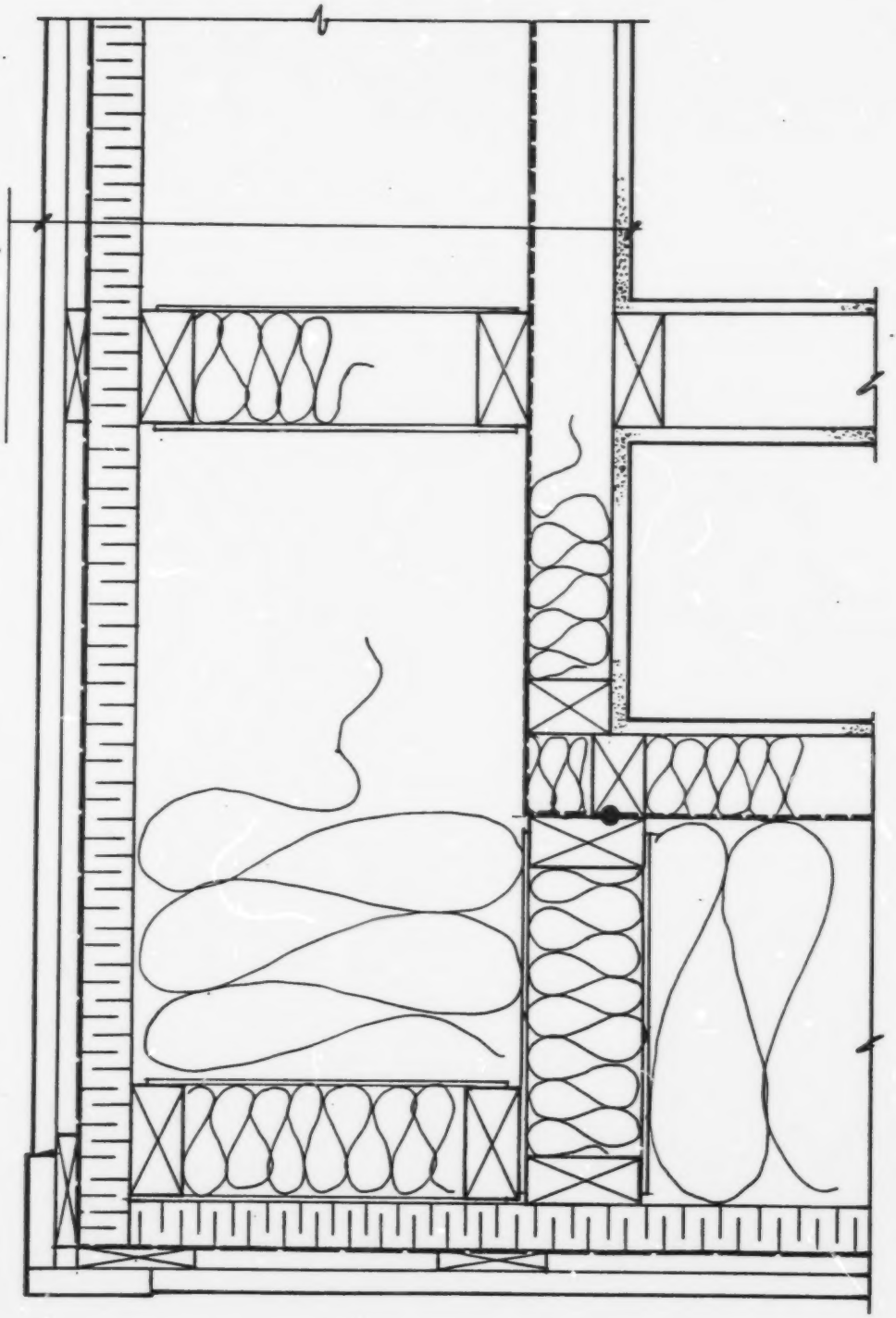
Practical Application:

- system is materials and labour intensive as shown

AGW	BGW	RF	I		DATE	SCALE	DRWG#
72	--	--	07		12/84	1:5	81

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

Siding
Strapping
"Tyvek" air barrier
Rigid ins.
Wall trusses w
batt ins.
Poly a.v.b.
Strapping w batt
ins.
GWB



AGW	BGW	RF	I		DATE	SCALE	DRWG#
72	--	--	07		12/84	1:5	81

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

FOOTING DETAIL EXPANDED STUD VARIATION

This detail is part of an expanded stud system in which an entire two or three storey wall is prefabricated on site and lifted into place.

Technical Performance:

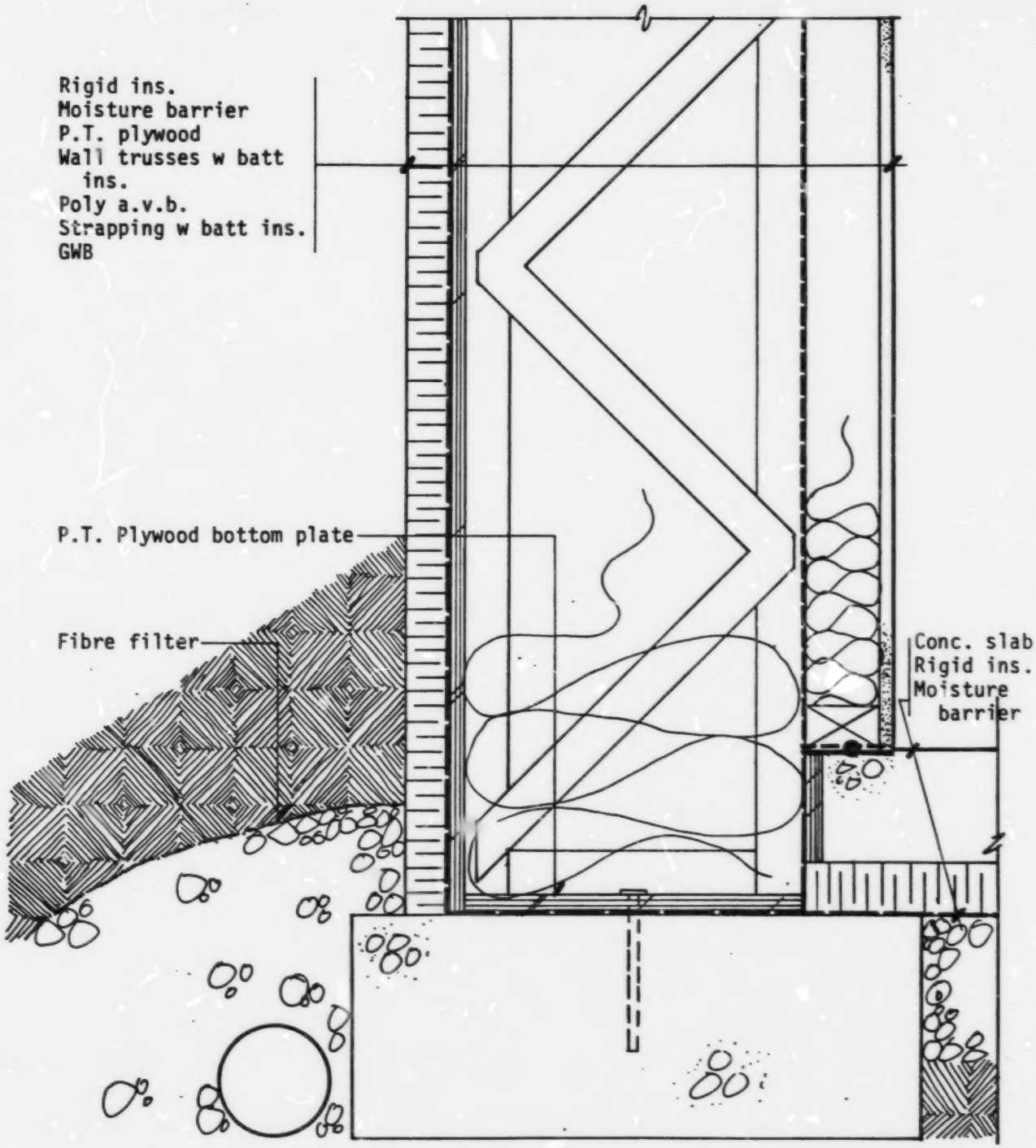
- below grade wall truss must be pressure treated
- fasteners used below grade, including metal webs, should be stainless steel

Practical Application:

- wall trusses are manufactured in single lengths from footing to eave with pressure treated stock used for below grade portions only
- system requires crane for erection

AGW	BGW	RF	I		DATE	SCALE	DRWG#
	25	--	03		12/84	1:5	82

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
	25	--	03		12/84	1:5	82

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

SILL DETAIL, EXPANDED STUD VARIATION

This detail is part of the expanded stud system described in the previous two drawings.

Technical Performance:

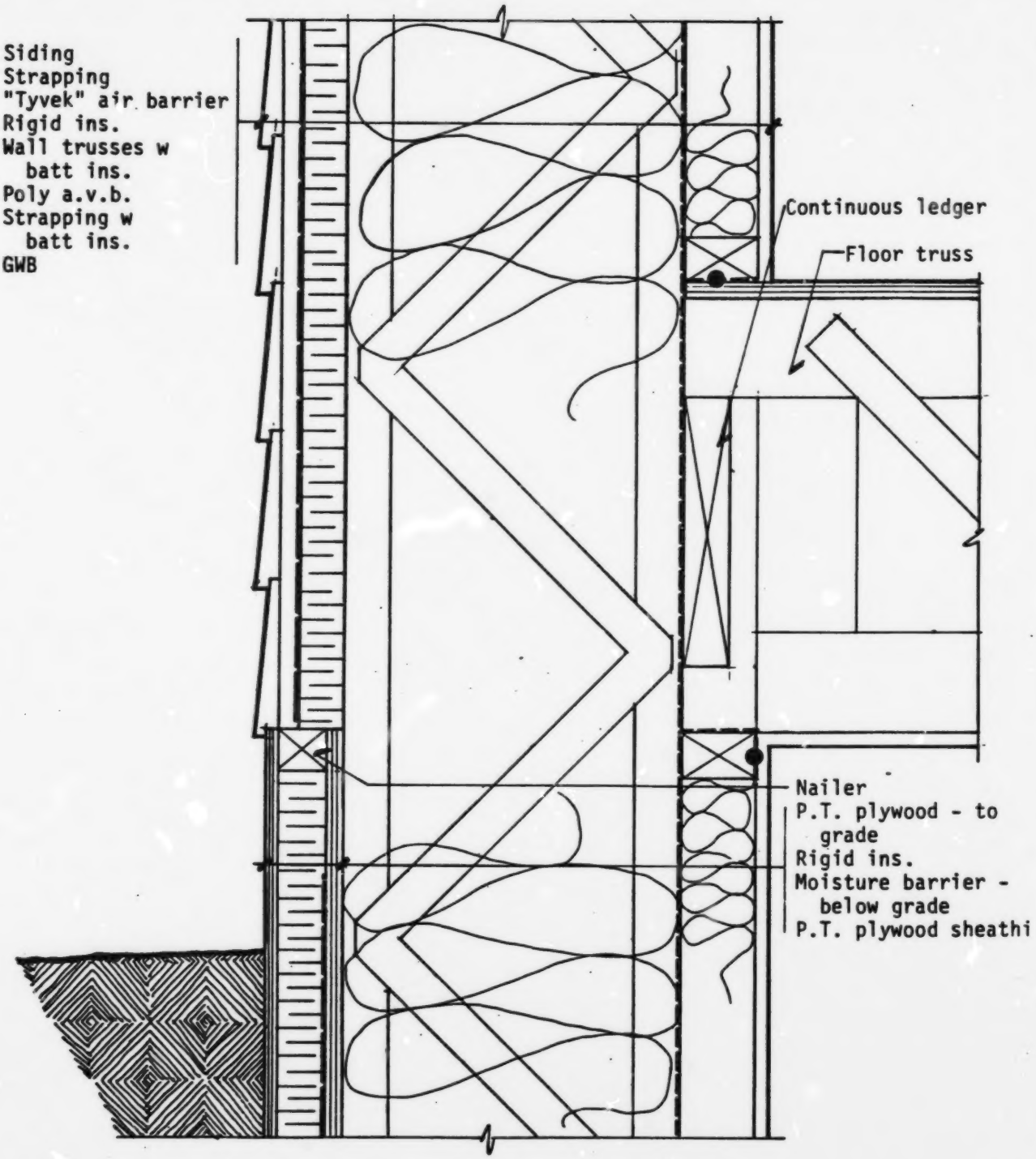
- ledger plate must provide adequate bearing for floor trusses and fasteners should be specified
- below grade portion of wall truss must be pressure treated
- fasteners used below grade, including metal webs, should be stainless steel

Practical Application:

- system requires simplication. Interior strapping could be eliminated, provided blocking was installed to support polyethylene drywall joints

AGW	BGW	RF	I		DATE	SCALE	DRWG#
72	25	--	01		12/84	1:5	83

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
72	25	--	01		12/84	1:5	83

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

EAVE, RAISED HEEL TRUSS ON EXPANDED STUD WALL

This detail shows a wedge heel truss bearing on a truss wall.

Technical Performance:

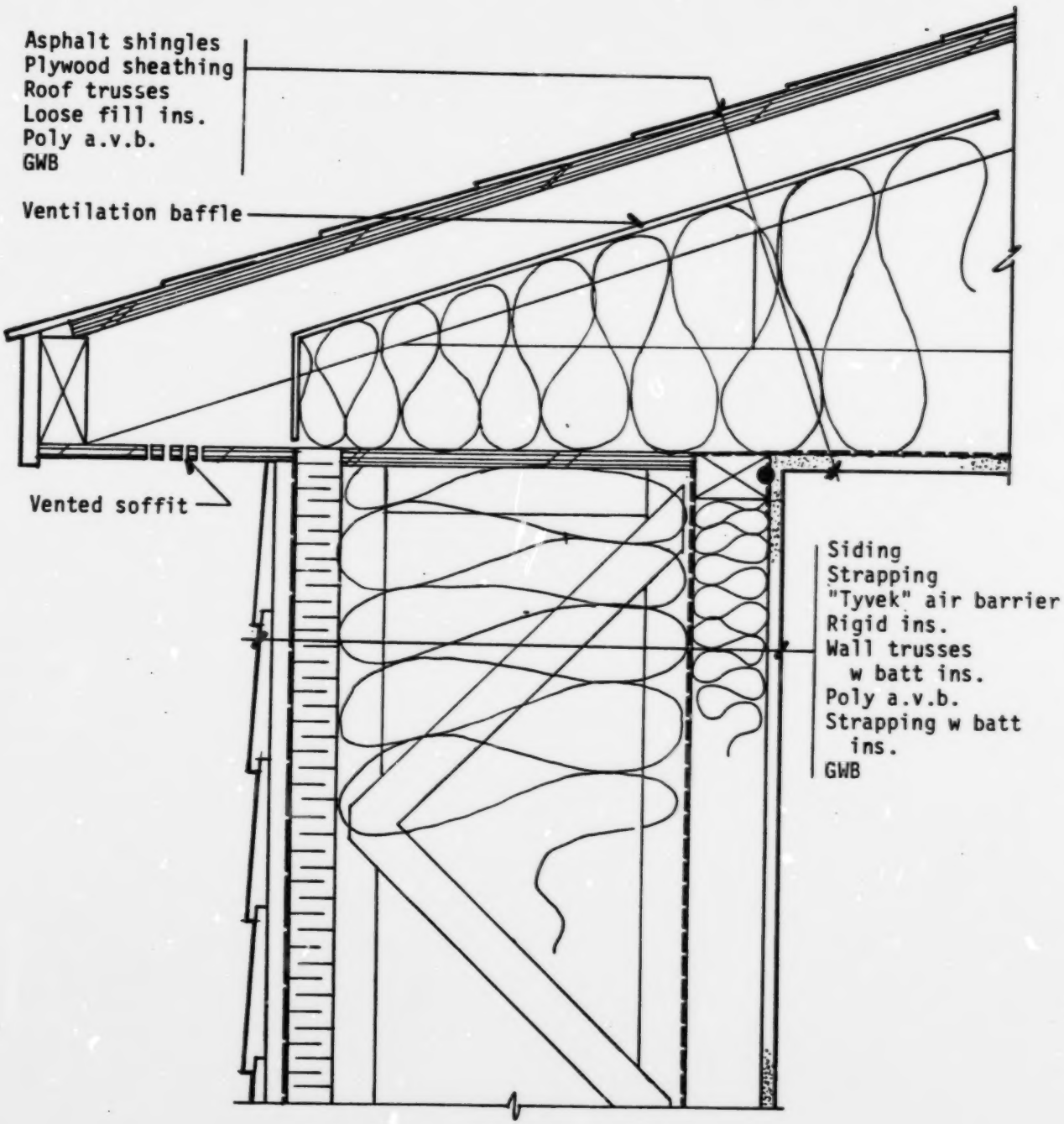
- insulation levels at the eave are considerably lower than those of the wall

Practical Application:

- wall system could be simplified by eliminating interior strapping

AGW	BGW	RF	I		DATE	SCALE	DRWG#
72	--	31	10		12/84	1:5	84

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



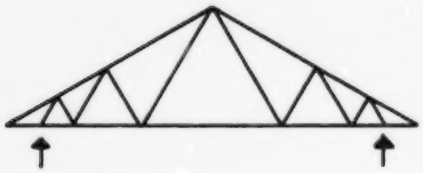
AGW	BGW	RF	I		DATE	SCALE	DRWG#
72	--	31	10		12/84	1:5	84

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

ROOFS

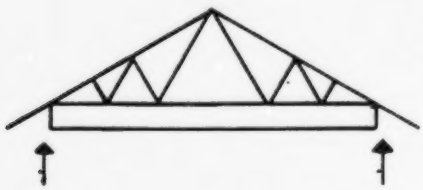
The selection of roof type may be made independently of wall type. Nine different roof systems were documented in this study although the vast majority of builders reported using a flat bottom raised heel truss.

The major roof types are:



RF 31 Raised heel trusses

These are conventional W trusses or equivalent in which the eave detail has been modified to provide additional depth for insulation at the bearing wall. There are several methods of making this modification depending on the depth required.



R 32 Dropped chord trusses

These are standard trusses to which a dropped ceiling joist is added either by the manufacturer or on site.

R 33 Scissors trusses

The scissors truss provides a sloped ceiling and adequate depth for insulation provided a raised heel configuration is used.

R 34, 35 Parallel chord trusses

Floor trusses may be used as rafters and for cathedral ceiling applications.

R 37 Rafters with ceiling joists

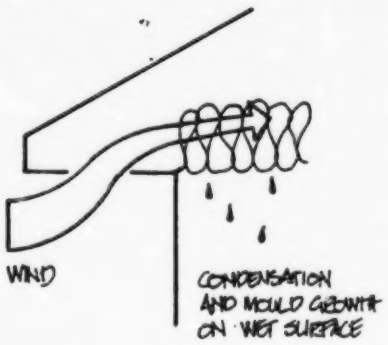
Builders using this traditional method have modified the eave detail to provide space for additional insulation

R 38 Rafters with purlins

This method uses standard lumber to provide a sloped ceiling.

ROOFS (cont'd)

General Considerations:



- eaves require an air barrier, usually a vertical extension of the ventilation baffle, to prevent air circulation through the insulation from the soffit vents
- eaves must be designed so that adequate insulation levels are maintained
- assemblies should be designed so that thermal bridging through structural assemblies is minimized
- insulation must be properly installed around structural members to reduce convection losses
- a good air seal should be maintained at all ceiling and roof penetrations including wiring, plumbing stacks, chimneys and flues, partitions and access hatches

RAISED HEEL TRUSSES

The amount of space available for insulation and ventilation at the eave depends on the pitch of the roof, the configuration of the truss and the location of the bearing for the truss in the insulated wall.

Trusses have the advantage in that they can be erected as a clear span. In addition to facilitating construction time, this allows for an air-vapour barrier to be installed in one large continuous sheet. Generally, the raised heel truss results in a minor increase in exterior sheathing and siding. If extra depth at the eaves is needed then the top and bottom chord must be reinforced and additional struts and web members may be required. Standard components may be used but the cost will be increased.

Refer to Drawings

DROPPED CHORD TRUSSES

The dropped chord provides full insulation value to the perimeter wall and appears to eliminate the risk of truss uplift. It also protects the ceiling insulation from wind-driven blow through. However, this system is much more materials intensive than raised heel trusses in that taller wall studs are required, as is extra siding. There is also the requirement for blocking at the interior ceiling-wall junction.

Refer to Drawing

SCISSOR AND PARALLEL CHORD TRUSSES

These systems are used when sloped ceilings are desired for architectural reasons. Insulation must be installed around the web members. If metal cross webs are used, then there can be high heat losses because of thermal bridging.

Refer to Drawings

RAFTER ROOFS

Approximately 12 per cent of the surveyed units incorporated rafter roofs. To obtain higher levels of insulation at the perimeter the rafters bear on a plate installed on the top of the ceiling joists, rather than on the top plate of the wall. Sloped ceilings are framed conventionally and purlins are added on top of the rafter to provide a ventilation space above the insulation.

Refer to Drawings

ROOFS (cont'd)

INTERIOR PARTITION WALLS

Many builders erect partition walls after a clear span ceiling is installed with the air-vapour barrier and drywall. This provides an effective and easilfy installed air-vapour barrier. It does, however, break up the framing sequencing. Alternatively, some builders frame the partition wall but undercut it by 18 mm. Drywall is then slipped between the partition wall and ceiling and the wall anchored in place.

If partition walls are built conventionally (as in the case of a loadbearing partition) a strip of polyethylene is placed between or above the top plates of the partition wall. This polyethylene is later sealed to the ceiling air-vapour barrier.

RAFTER ROOF WITH CATHEDRAL CEILING AT RIDGE

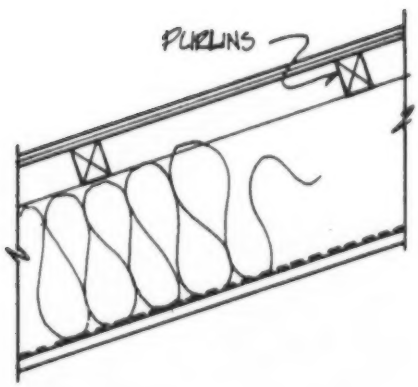
This detail illustrates air-vapour barrier placement when cathedral ceiling is supported by exposed gluelam beam. The opportunity to accommodate high insulation levels is limited by the dimensioning of the lumber. Thermal bridging across rafters might be significant. As drawn the detail does not accommodate ridge venting which would be required.

Advantages:

- provide good mechanical support for air-vapour barrier
- minimal additional labour requirements

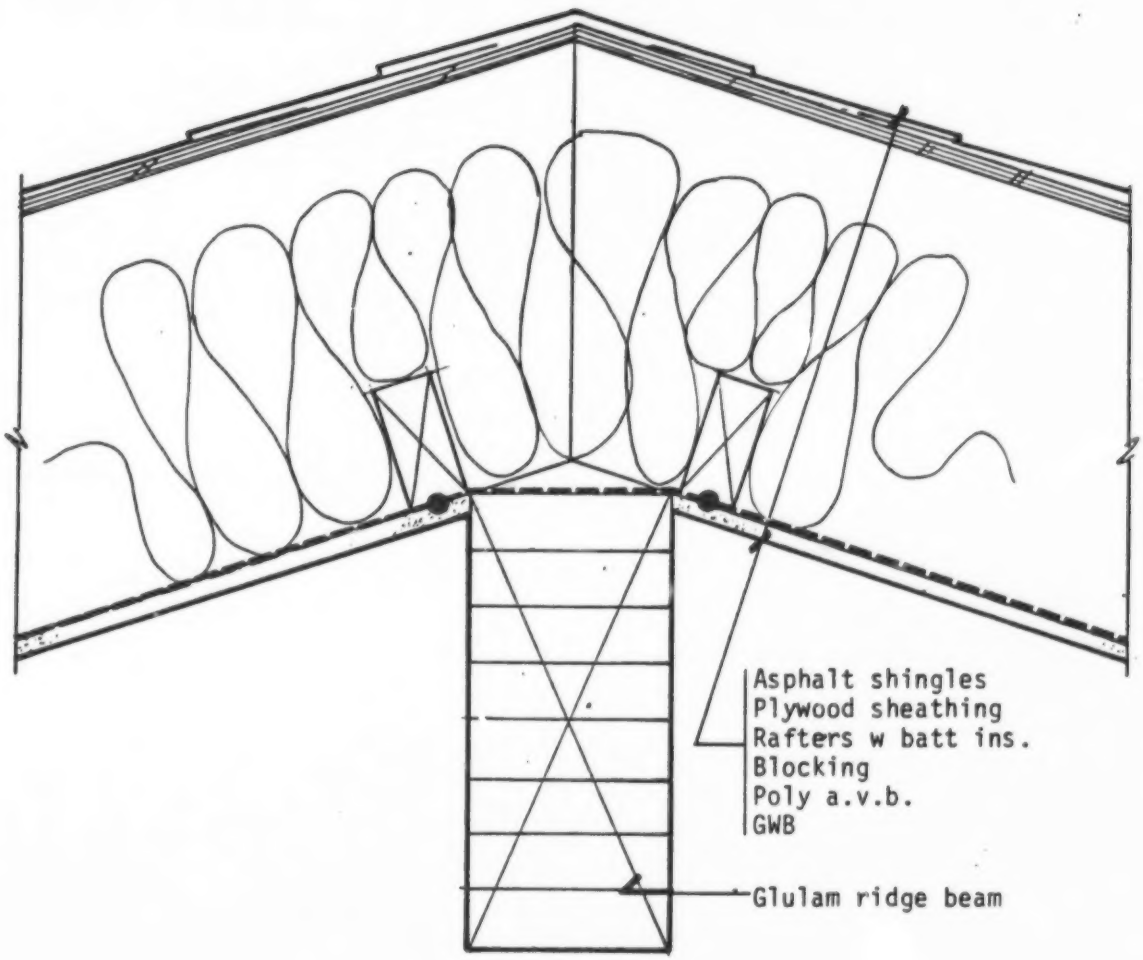
Disadvantages:

- air-vapour barrier may be damaged during rafter installation unless protected
- bevelled blocking above gluelam beam would be difficult to cut and might be omitted
- the addition of purlins over the rafters would permit greater insulation levels



AGW	BGW	RF	I		DATE	SCALE	DRWG#
--	--	37	16		12/84	1:5	85

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG #
--	--	37	16		12/84	1:5	85

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

SPLIT LEVEL CEILING

This detail illustrates air-vapour barrier and insulation installation techniques for a split level ceiling. A piece of the air-vapour barrier material is lapped over the wall top plate before roof joist installation.

Advantages:

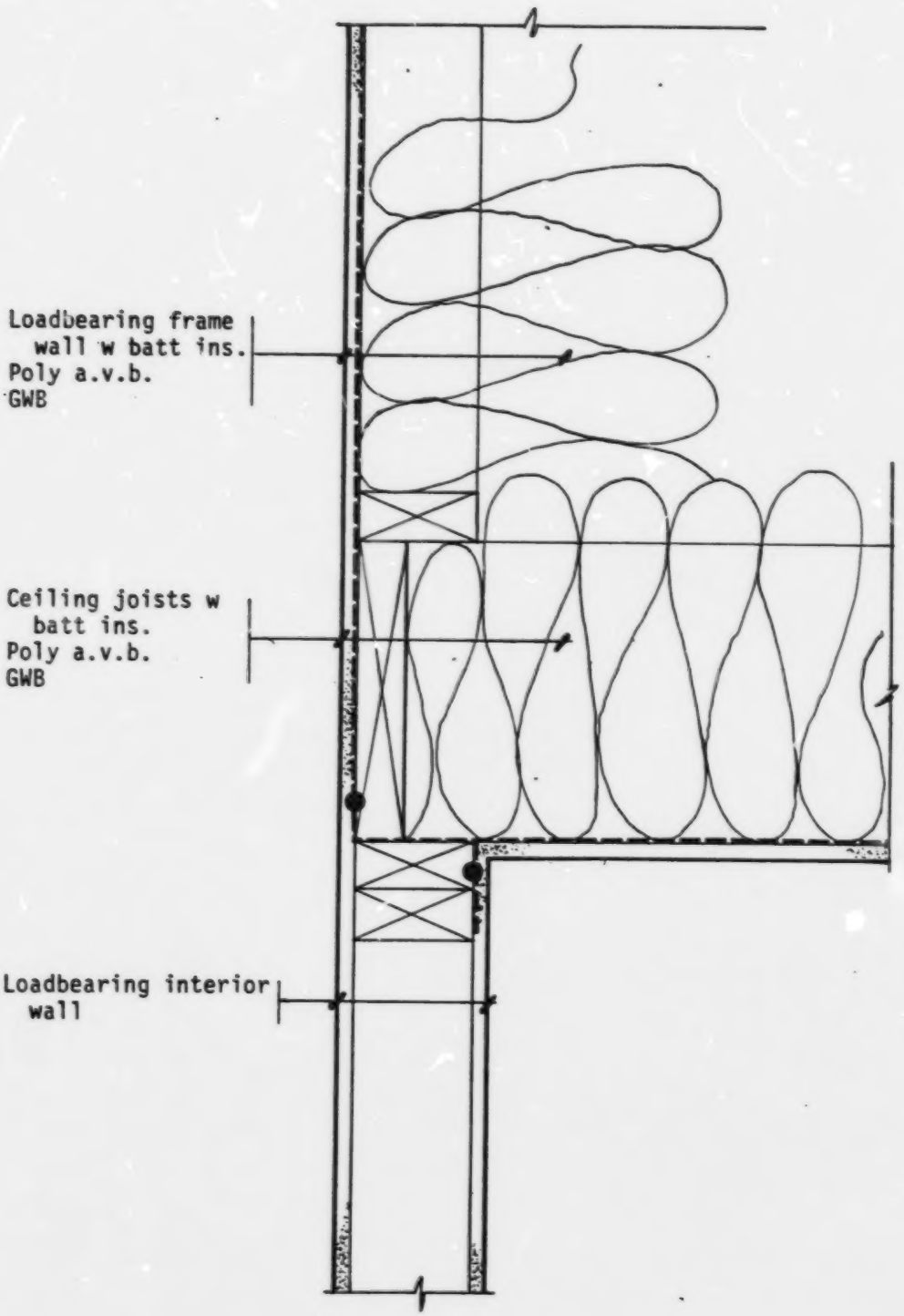
- employs conventional materials
- standard framing techniques
- allows for installation of continuous air-vapour barrier

Disadvantages:

- an air barrier is needed on the cold side of the wall insulation to prevent convective losses
- gaps in the insulation will occur behind each stud
- air-vapour barrier is prone to damage during installation of roof joists. A preferred location would have the barrier sandwiched between the two top plates
- thermal bridging through ceiling joists may be significant

AGW	BGW	RF	I		DATE	SCALE	DRWG#
--	--		14		12/84	1:5 .	86

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
--	--		14		12/84	1:5	86

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

SPLIT LEVEL CEILING

This detail illustrates a cathedral ceiling framed with parallel cord trusses. The ceiling butts intc an insulated wall. The wall is framed in two sections to allow the air-vapour barrier to meet the air-vapour barrier from the ceiling at the underside of the roof truss.

Advantages:

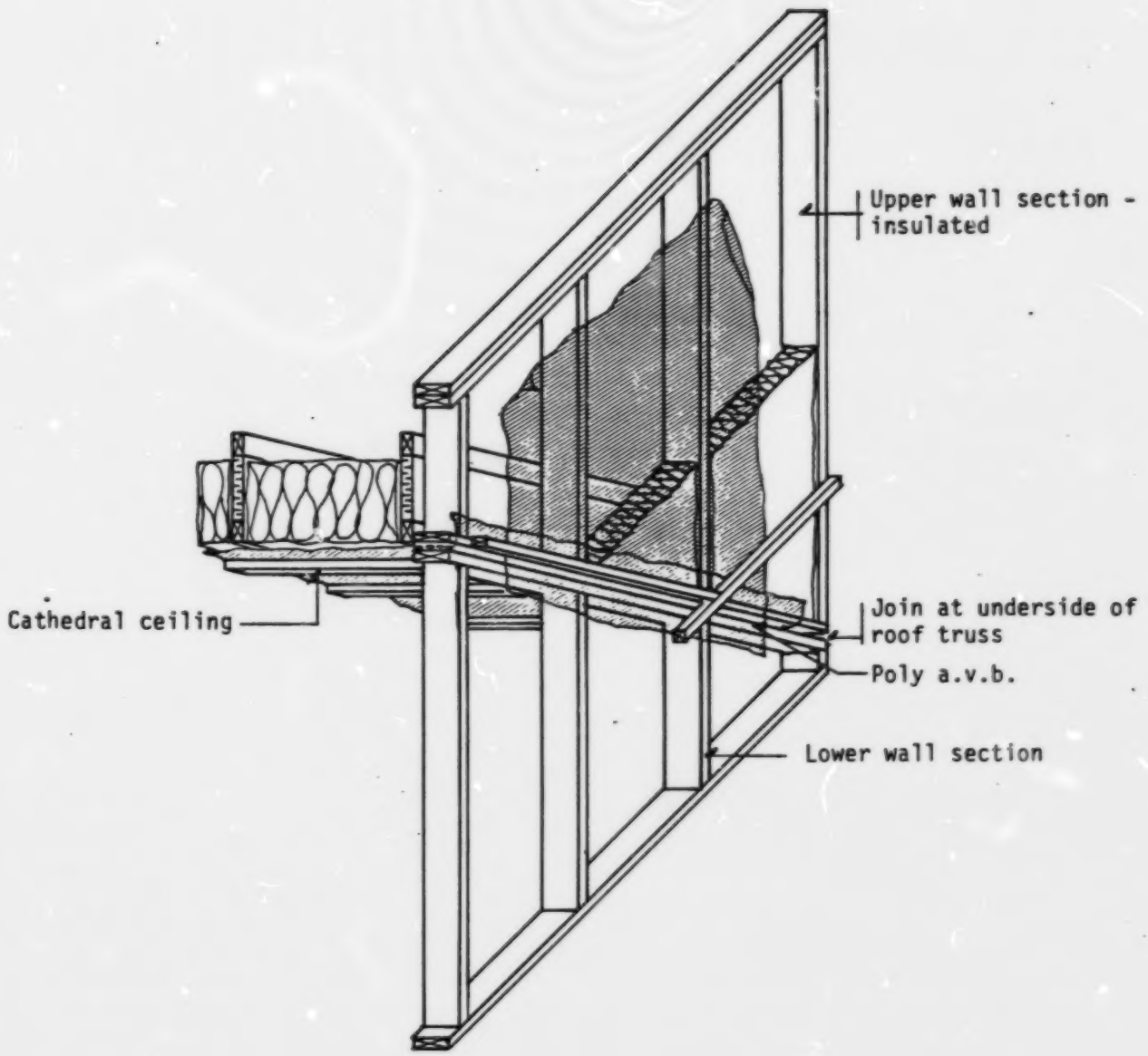
- this detail can provide good air and vapour sealing in an otherwise difficult to seal area
- employs conventional framing and insulation materials

Disadvantages:

- demands an alteration to conventional framing practices
- additional labour and materials costs will be incurred
- supervisory requirements are increased

AGW	BGW	RF	I		DATE	SCALE	DRWG#
22	--	25	14		12/84	1:5	87

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG #
22	--	25	14		12/84	1:5	87

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

PENETRATIONS AND OPENINGS

The drawings in this Section demonstrate various air sealing techniques. They are not specific to wall type. They are organized as follows.

Service Penetrations

I 32	Vent or pipe penetration through wall
I 33	Vent or pipe penetration through ceiling
I 36	Chimney penetration through ceiling
I 47	Electrical wall outlet
I 48	Electrical ceiling outlet

Window Opening

I 22	Window wrap

PIPE PENETRATION THROUGH WALL

This detail illustrates a manufacturer's accessory kit intended to provide an airtight seal at air intake and exhaust hoods.

Advantages:

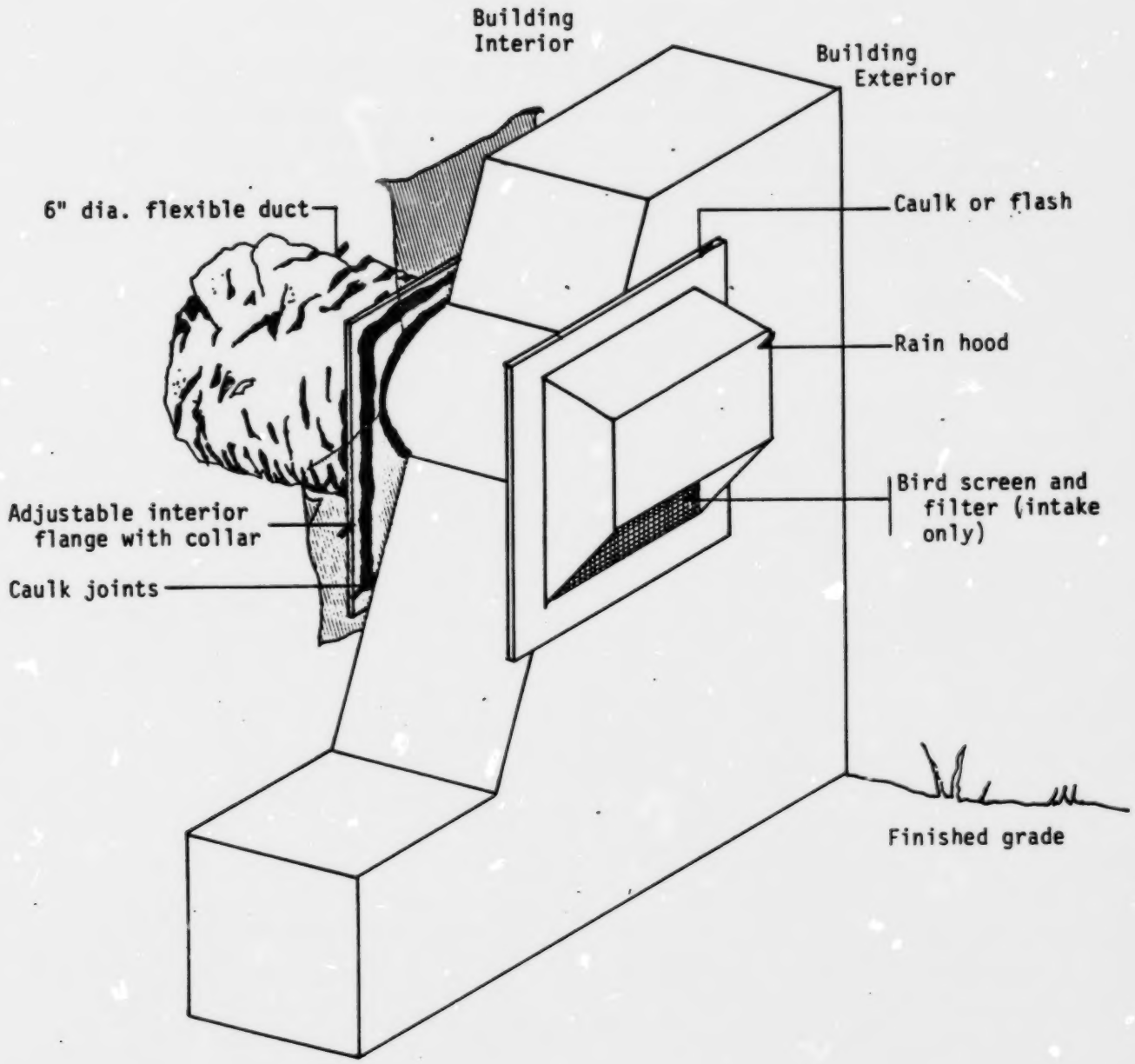
- a simple method of providing an airtight seal

Disadvantages:

- solid backing is required behind air-vapour barrier

AGW	BGW	RF	I		DATE	SCALE	DRWG #
--	--	--	32		12/84	N.T.S.	88

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG*
--	--	--	32		12/84	N.T.S.	88

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

PIPE OR VENT PENETRATION THROUGH CEILING

This detail illustrates a low cost sealing detail to accommodate the expansion and concentration of plumbing vents running through house ceilings. A sheet of butyl rubber is clamped to the top plate of a partition wall using plywood to provide mechanical support. The butyl is then cut to allow the pipe to penetrate.

Advantages:

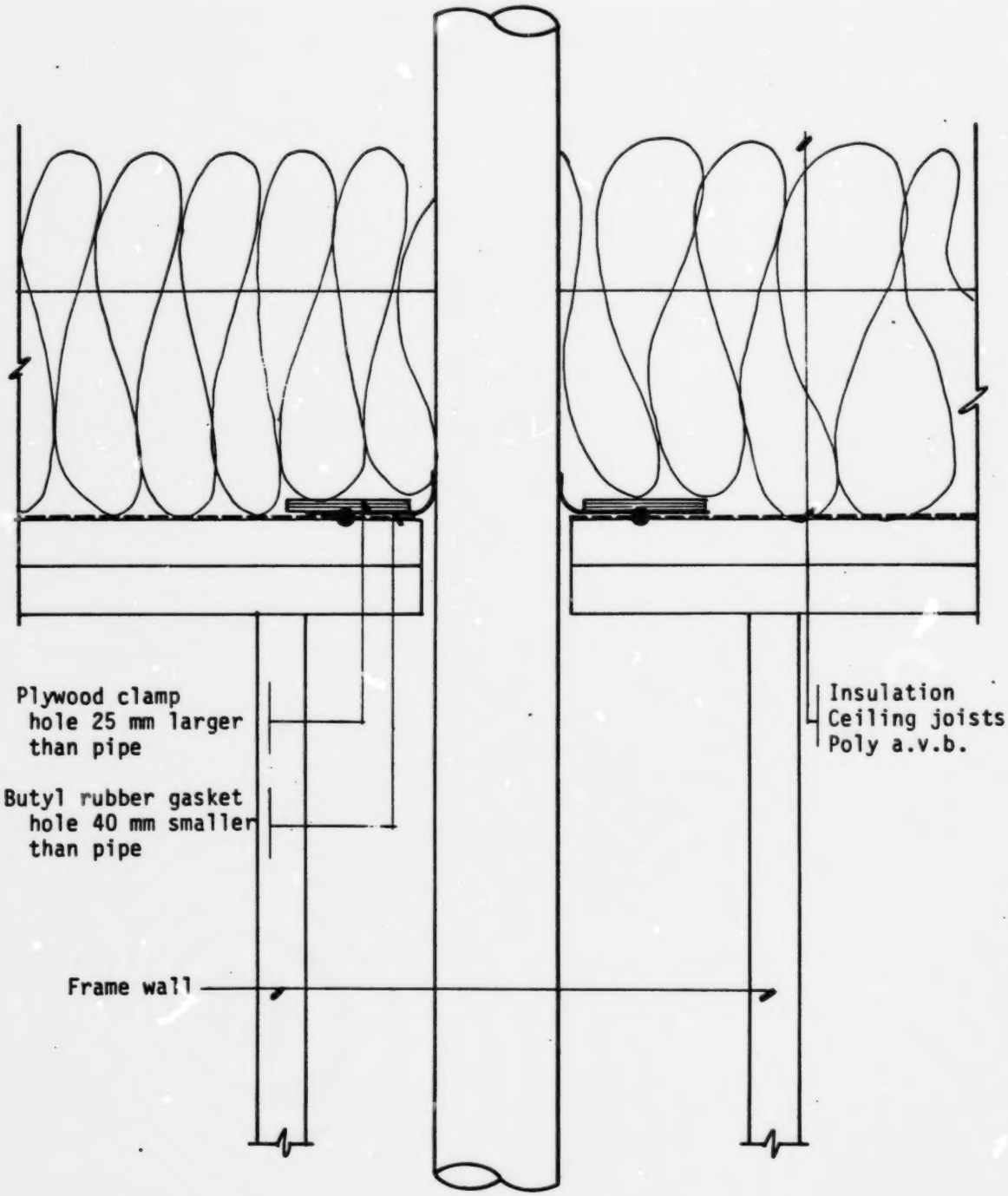
- low cost of materials
- minimal additional labour

Disadvantages:

- sourcing of butyl rubber gasketing may prove difficult

AGW	BGW	RF	I		DATE	SCALE	DRWG#
--	--	--	33		12/84	1:5	89

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
--	--	--	33		12/84	1:5	89

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

PIPE OR VENT PENETRATION THROUGH CEILING

This detail illustrates a technique which is designed to accommodate the expansion and contraction of plumbing stacks. The detail shows the use of a standard rubber roof flashing collar which is blocked and sandwiched to the air-vapour barrier. Method requires a strapped ceiling.

Advantages:

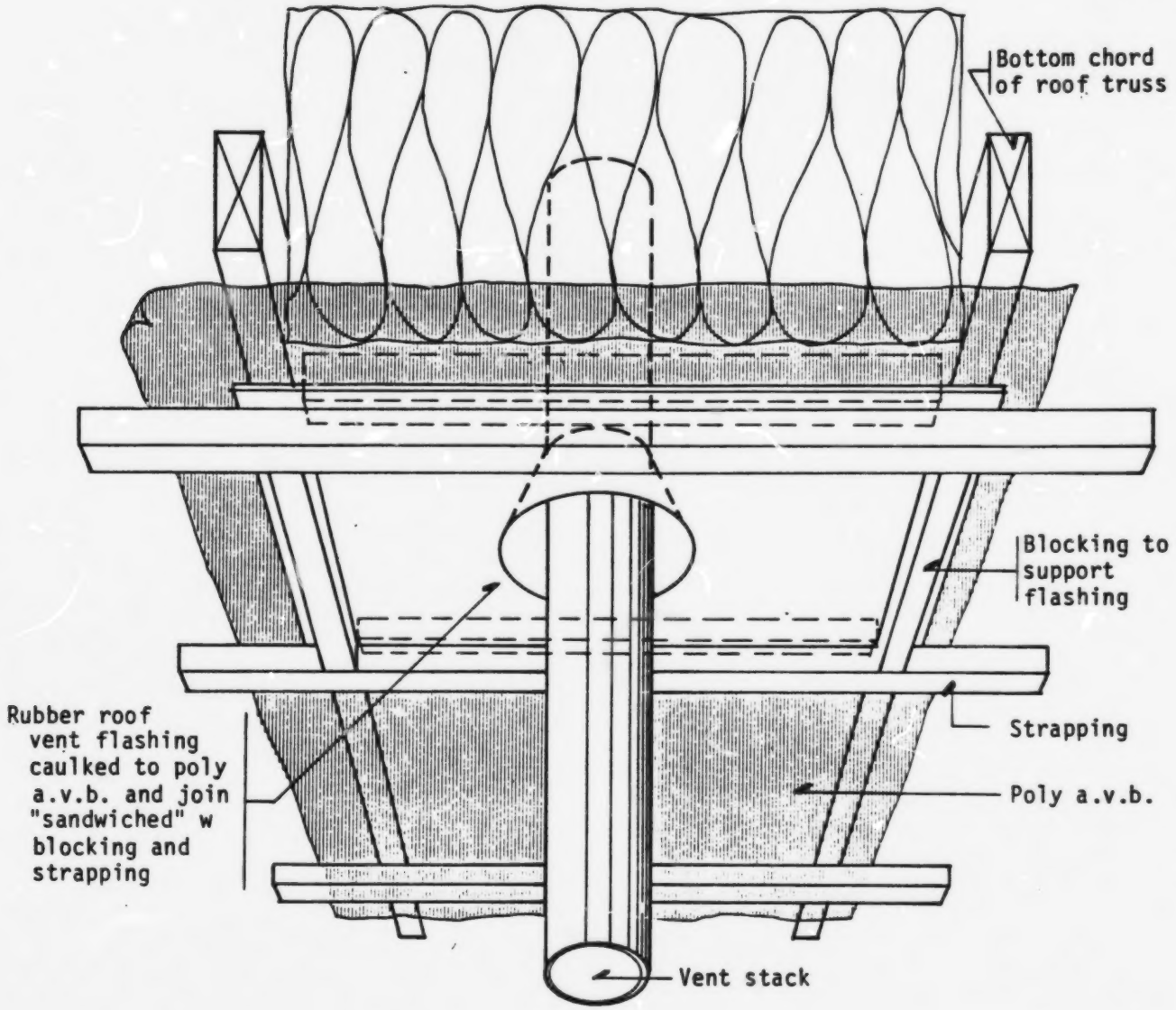
- provides effective seal to air and vapour passage
- uses readily available components

Disadvantages:

- requires cross strapping

AGW	BGW	RF	I		DATE	SCALE	DRWG#
--		--	33		12/84	1:5	90

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.


Bottom chord of roof truss
Blocking to support flashing
Strapping
Poly a.v.b.
Rubber roof vent flashing caulked to poly a.v.b. and join "sandwiched" w blocking and strapping
Vent stack

AGW	BGW	RF	I		DATE	SCALE	DRWG#
--		--	33		12/84	1:5	90

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

CHIMNEY PENETRATION OF INSULATED CEILING

This detail illustrates a technique for air sealing at the penetration of a chimney through the house ceiling. Two metal firestops are used to provide an air seal and a small cavity for insulation. The sheet metal is sealed to the air-vapour barrier at the blocking, and to the chimney with a muffler or stove cement.

Advantages:

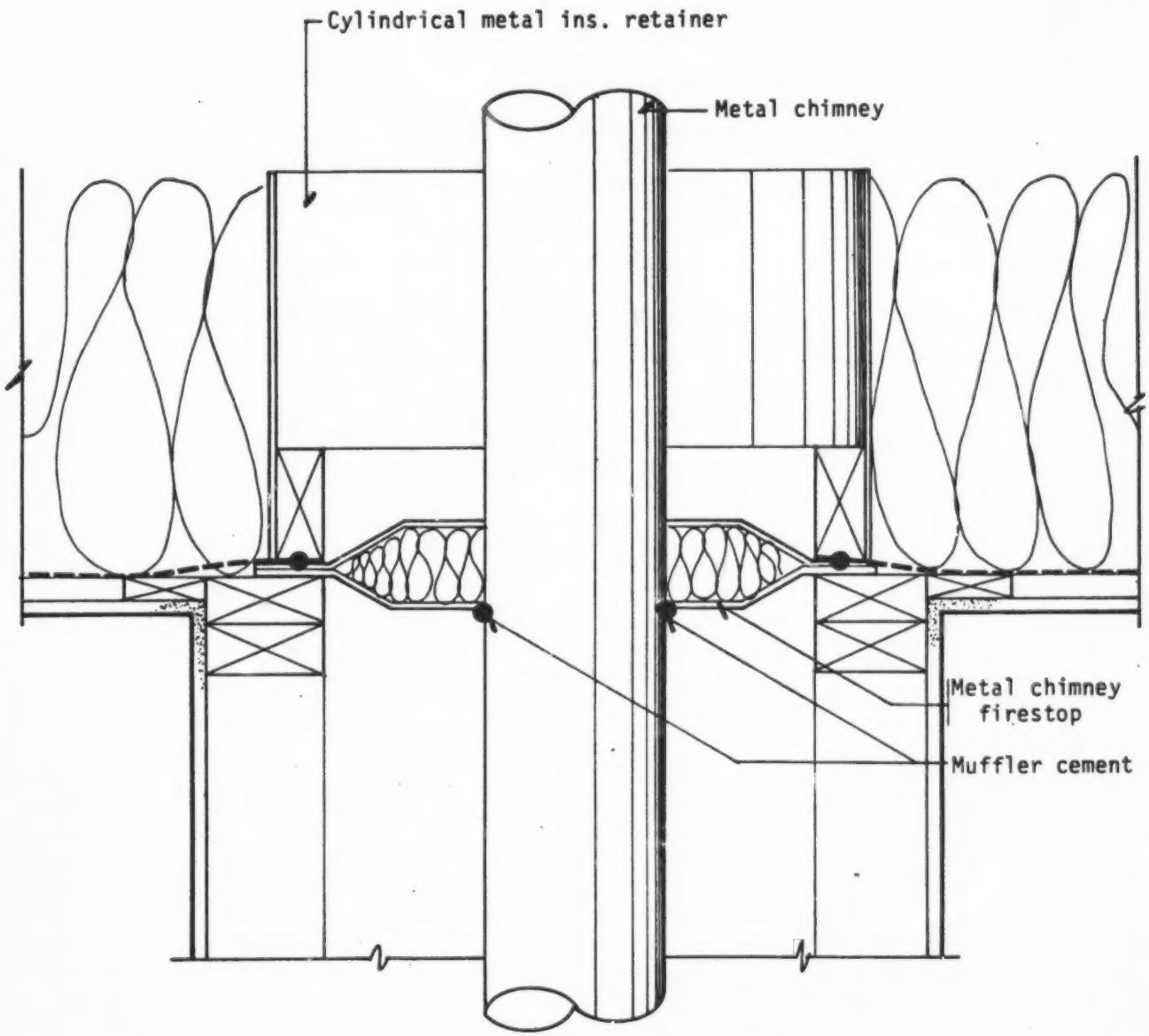
- this system assumes that all fire regulations are met providing that the insulation sandwiched between the sheet metal is fire retarded

Disadvantages:

- some manufacturers will not warantee metal chimneys if insulation contacts the surface of the chimney
- muffler cement will harden and probably crack when chimney expands and contracts. The use of a high temperature silicone caulk would provide a more flexible seal
- a significant amount of work is required to sandwich a very small amount of insulation

AGW	BGW	RF	I		DATE	SCALE	DRWG #
--	--	--	36		12/84	1:5	91

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
--	--	--	36		12/84	1:5	91

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

ELECTRICAL WALL OUTLETS, MANUFACTURED AIR VAPOUR BARRIER BOX

The polypropylene air-vapour barrier box illustrated in this drawing is a low cost technique to reduce air and vapour leakage around and through electrical boxes. The boxes are available in different configurations (single, double and triple gang, octagonal, and larger sizing for stove and dryer applications) to meet most house wiring applications.

Advantages:

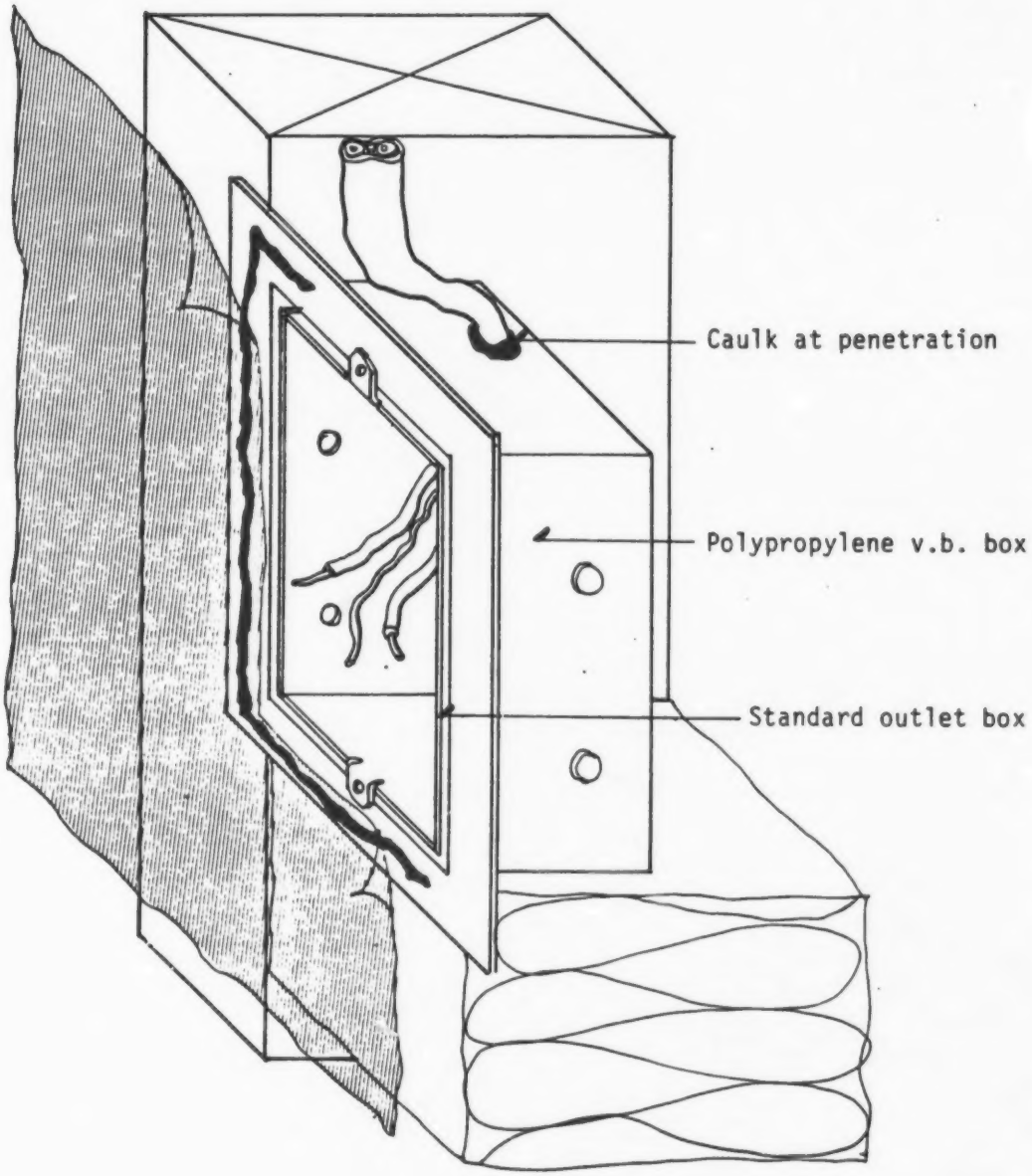
- low cost of materials
- can provide an effective air vapour seal

Disadvantages:

- requires careful installation to achieve good air seal
- flexibility of polypropylene may require some additional blocking to provide backing for flanges
- the working room within the boxes is limited causing an inconvenience to some electricians
- sourcing of the air-vapour barrier boxes may be difficult

AGW	BGW	RF	I		DATE	SCALE	DRWG #
--	--	--	47		12/84	1:5	92

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
--	--	--	47		12/84	1:5	92

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

ELECTRICAL WALL OUTLETS, PREFABRICATE AIR VAPOUR BARRIER BOX

This site fabricated box can allow good air and vapour barrier sealing around electric outlets. The hole drilled for the wire should be caulked from both sides to prevent leakage around the wire. The main air-vapour barrier on the walls can be easily caulked and stapled to the flange of the box.

Advantages:

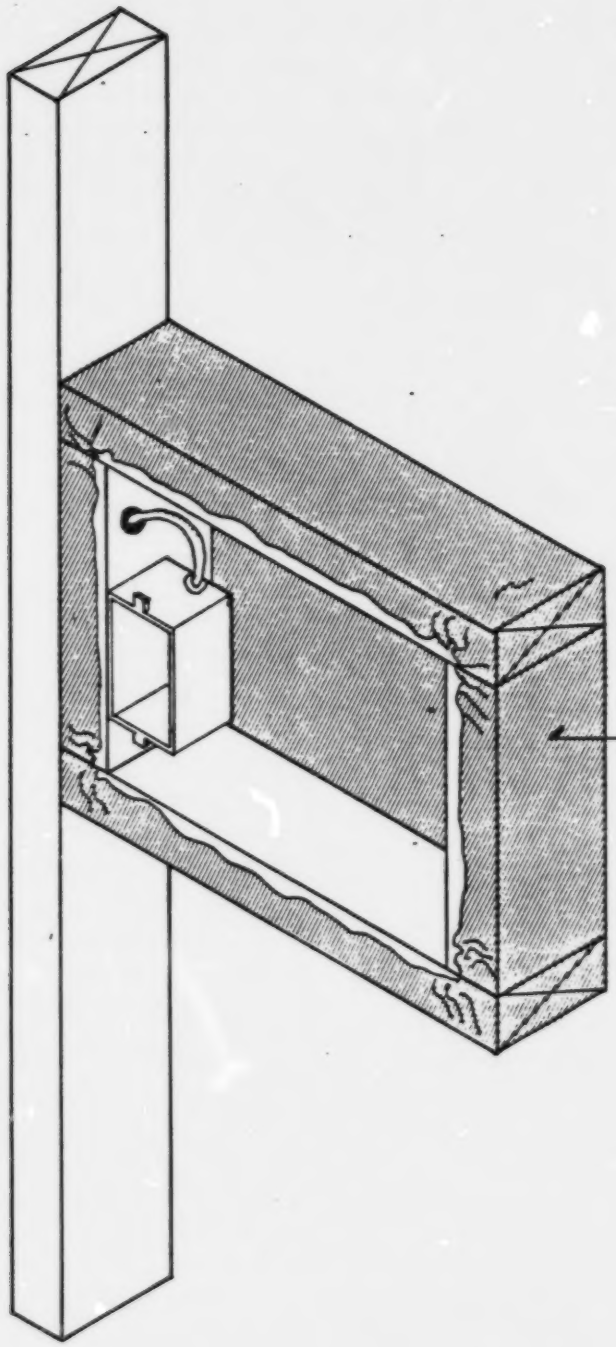
- good air seal is attained with the only penetration in the air barrier being the small drilled hole
- allows standard trade sequencing
- eliminates requirement for cross strapping

Disadvantages:

- additional labour and materials costs
- potential for the air-vapour barrier to be located beyond the dew point temperature

AGW	BGW	RF	I		DATE	SCALE	DRWG#
--	--	--	47.		12/84	1:5	93

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
--	--	--	47		12/84	1:5	93

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

ELECTRICAL OUTLET AT CEILING WITH CROSS STRAPPING

This system allows easy wiring and installation of electrical fixtures without disrupting the air-vapour barrier. 38 x 38 m strapping is run perpendicular to the ceiling joists with additional blocking for mounting of boxes as required. Wiring can usually be fished between the cross strapping and the air-vapour barrier reducing the need for drilling. The detail as drawn could have followed this practice.

Advantages:

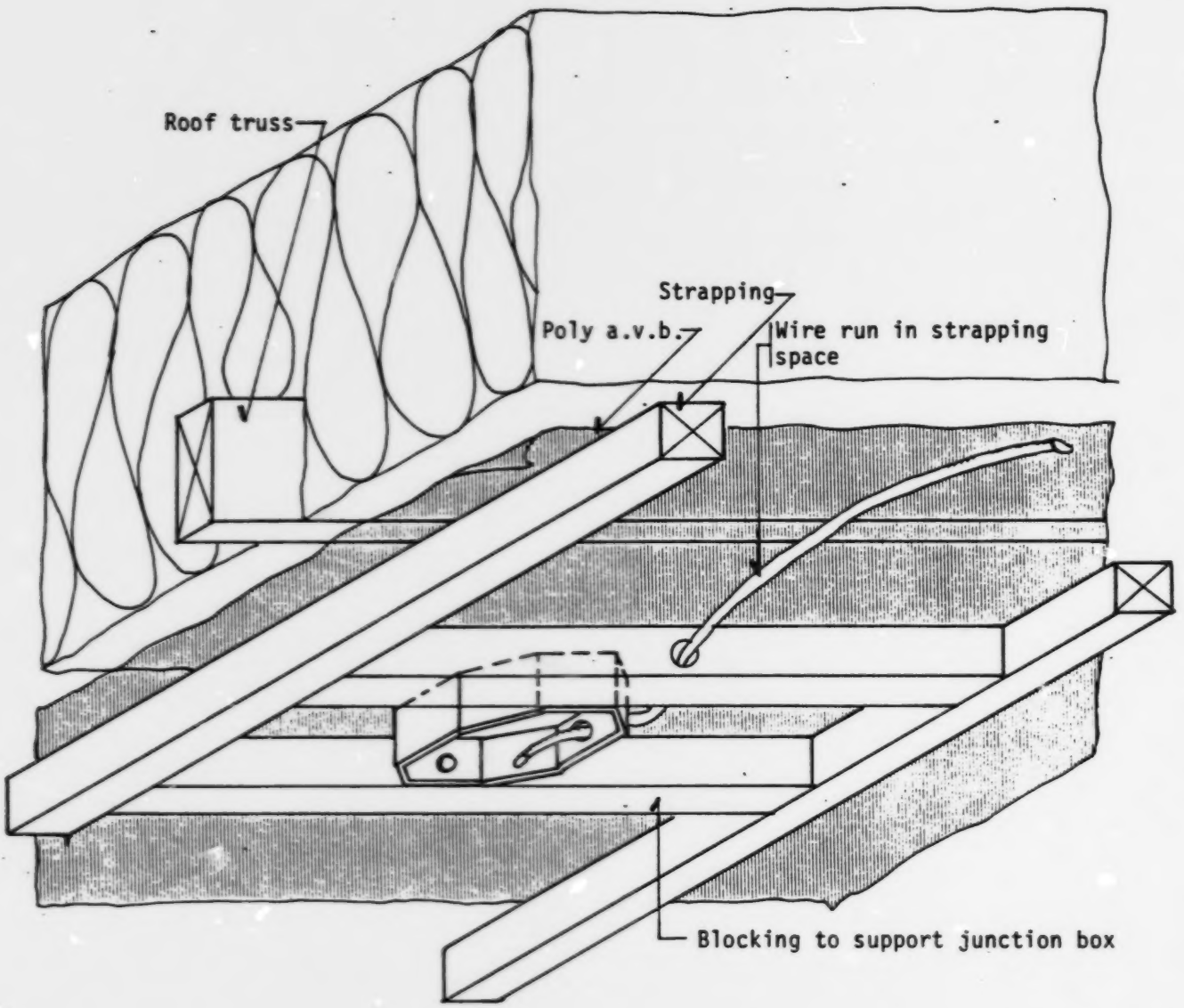
- cross strapping can reduce the effects of truss uplift
- allows air-vapour barrier to remain intact and reduces likelihood of damage during drywall installation

Disadvantages:

- labour and material costs

AGW	BGW	RF	I		DATE	SCALE	DRWG#
--	--	--	48		12/84	1:5	94

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
--	--	--	48		12/84	1:5	94

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

ELECTRICAL OUTLET AT CEILING - NO STRAPPING

This standard ceiling mounted electrical fixture is mounted over a blocking piece spanning between ceiling joists. The blocking is drilled to accept the wiring before the drywall is installed. The area around the wire is caulked and the air-vapour barrier is caulked and stapled to the blocking. Alternatively the electrician could work from above and drill the hole after the drywall was installed.

Advantages:

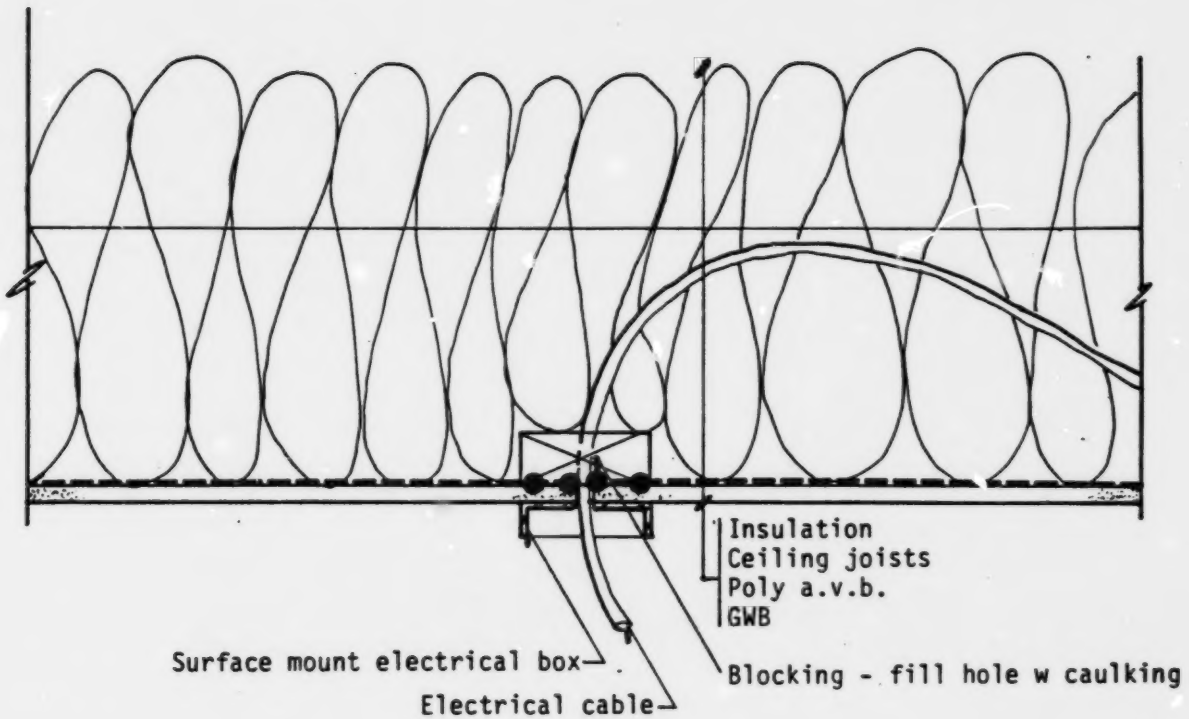
- if only a few outlets are required this can be performed without the expense of cross strapping
- lighting fixtures must match the surface mounted box

Disadvantages:

- feeding wire through drywall may be tricky

AGW	BGW	RF	I		DATE	SCALE	DRWG #
			48		12/84	1:5	95

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
			48		12/84	1:5	95

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.

WINDOW INSTALLATION USING POLYETHYLENE WRAP

The technique presented here allows a wood window unit to be directly tied in with a wall air-vapour barrier. The polyethylene is caulked and stapled to the window frame. Corners are pleated on both sides. Once the window is in place, this will allow the polyethylene to be folded back and caulked to the wall air-vapour barrier. Staples should be reinforced with tape to resist tearing.

Advantages:

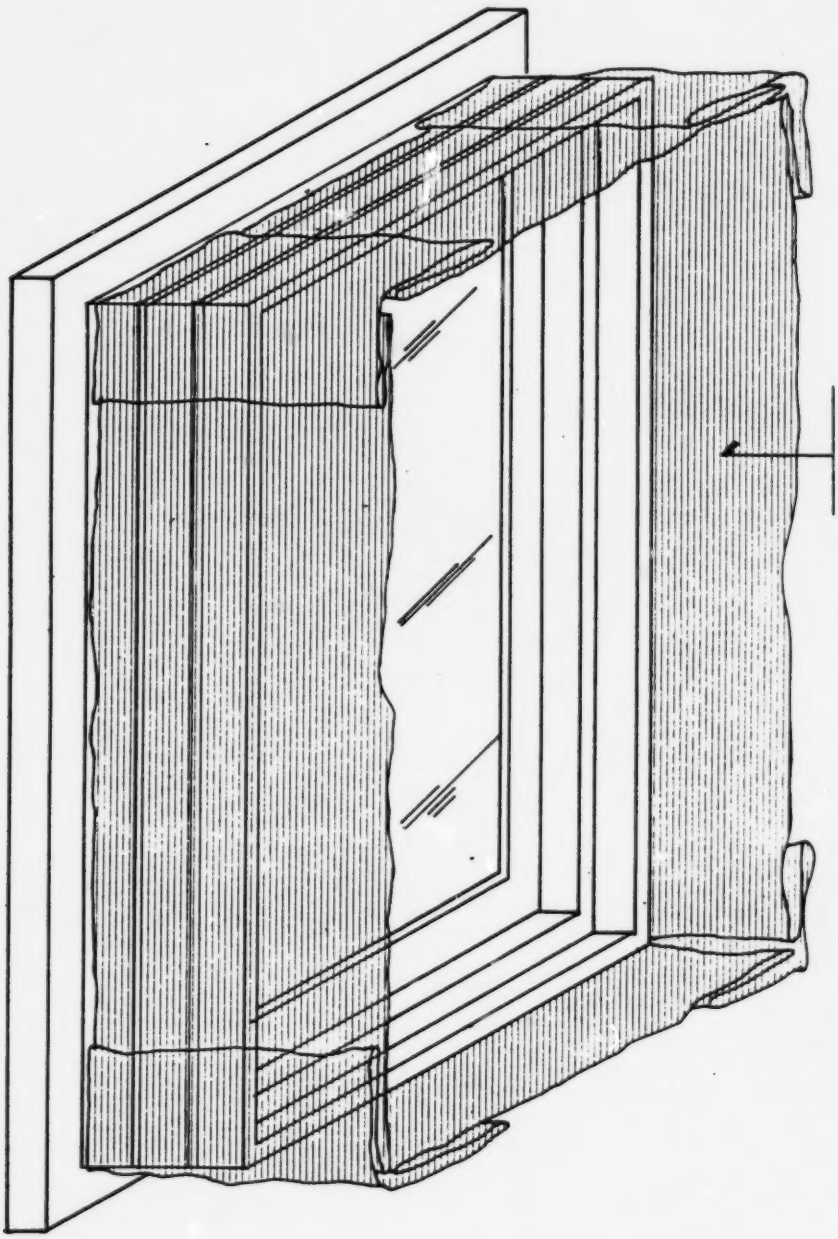
- forms a continuous air barrier from the wall to the window
- the pleats allow the polyethylene to be opened against the main air-vapour barrier at the corners without cutting

Disadvantages:

- this technique is labour intensive; care must be taken to install properly
- sealant has to be injected into each pleat
- this technique is not appropriate for aluminum windows

AGW	BGW	RF	I		DATE	SCALE	DRWG#
			22		12/84	1:5	96

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD., to be used for documentary purposes only.



AGW	BGW	RF	I		DATE	SCALE	DRWG#
			22		12/84	1:5	96

Drawn for CMHC under File no. 6350-18 by ALLEN-DRERUP-WHITE LTD.,to be used for documentary purposes only.

APPENDIX A

COMPUTER AIDED DRAFTING STUDY

REPORT PREPARED BY

AEC INFORMATION SERVICES LTD.

FOR

ALLEN-DRERUP-WHITE LTD.

NOVEMBER 1984

COMPUTER AIDED DRAFTING STUDY

1.0 SUMMARY AND RECOMMENDATIONS

2.0 HISTORICAL BACKGROUND

3.0 RANGE OF CAPITAL COSTS AND FEATURES

4.0 CAD SYSTEMS OVERVIEW

5.0 CAD SYSTEM EVALUATION

6.0 EQUIPMENT SELECTION PROCESS

7.0 DETAILS LIBRARY & DATA BANK UTILIZATRION

8.0 EXTERNAL USER REQUIREMENTS

9.0 MAINTENANCE OF STANDARD LIBRARY

10.0 ANTICIPATED FUTURE DEVELOPMENTS

1.0 SUMMARY AND RECOMMENDATIONS

Current computer aided drafting systems were reviewed and the features of three of the more powerful systems were compared. Some practical considerations surrounding the establishment of a library of details were outlined.

Findings

1. There exists today a variety of computer aided drafting (CAD) tools which are supplanting the use of conventional methods of producing drawings on large construction projects.

2. CAD systems which are sufficiently flexible and powerful to compete effectively with conventional drafting techniques are currently limited in application to large design firms because of the high capital cost of the equipment ($100,000-$500,000) and because of the specialized skills required of the system operators.

3. Low cost systems (under $30,000) are evolving rapidly and prices are dropping.

4. The technology exists for designers and builders to store, retrieve and modify building details on CAD systems and to access remote data banks electronically.

5. A CAD library of details is potentially a more powerful tool than a manually-assembled library. Multiple search criteria are possible so that individual details can be sourced by, for example, R values, fire ratings, building interface, construction type etc. Associated commentary can be stored and recalled. Three dimensional projections and other views can be easily generated. Drawings can be quickly updated. Integration with specification writing and estimating programs is feasible.

6. A centralized CAD library should be able to provide reproducible hard copies to its users as well as electronic access to enable any builder to make immediate use of the service.

Conclusions

1. **The establishment of a centralized library of details is a highly desirable goal which will be to the long term benefit of the Canadian housing industry and the homeowner.** Other studies, notably 'Construction R D & D in Canada' by Revay, 1983 have found inadequate levels of research and development in the Canadian construction industry. The results of the details project indicate that builders are applying inadequate resources to the development of new construction techniques in the housing industry to the point where working drawings often ignore or omit basic rules of sound construction practice. Access to a library of annotated details describing sound and current construction practice would result in an immediate and radical improvement in the level of information provided to the trades by the builder and small design firm.

1.0 SUMMARY AND RECOMMENDATIONS (cont'd)

2. A library suitable for the Canadian home building industry might logically be administered by the industry association, CHBA, with technical review functions provided by the various research and regulatory bodies. Operation costs of the system could reasonably be expected to be borne by the users however adequate monies would have to be allocated from research funds or other public sources to cover set up costs and future system expansion.

3. A task force of interested parties should be established to provide an indepth feasibility report including administrative and funding requirements and if appropriate, terms of reference for system or service supply tenders.

2.0 HISTORICAL BACKGROUND

From simple beginnings in the early 1960s, the theory and practice of computer aided drafting, design and manufacturing has developed into a sophisticated, economically feasible tool for the production of graphics.

In 1963, Ivan Sutherland first implemented a computer graphics program called "SKETCH PAD" as part of his doctoral dissertation at MIT. Initially, with the support of NASA, CAD/CAM grew in the industrial marketplace at a rate of 60 to 70 per cent per year until the late 1970s, and is still rapidly evolving with architecture, engineering and construction as major growth areas.

CAD/CAM has now developed to a point where it can be confidently predicted that, during the 1980s, every day use of computer aided design techniques will radically alter the construction industry.

Several factors have led to this rapid transition. First, basic research and development conducted over the last two decades have established some theoretical foundations recognized throughout the field. Secondly, an increasingly broad range of power and reliable computer software has been designed specifically for use in the practice of architecture. Finally, the rapidly decreasing costs of both hardware and software, brought about by widening availability, has brought computerization within the reach of even the smallest architectural firms.

2.1 INTEGRATION INTO CONSTRUCTION INDUSTRY

The computerization of the construction industry began with specifications, report generation and critical path scheduling. Electronic data processing equipment made possible the easy retrieval and editing of standard specifications and reports. With further developments in software, manipulation of complex interrelated scheduling networds (CPM, PERT), project managers were able to accurately monitor and anticipate the status of large construction projects.

Although this utilization of computers had some degree of success, it is important to note that its introduction as an aid during the last 40 per cent of a project, would only affect that portion of the project, and was dependent upon information extracted from the working drawing by manual methods.

Integration of CAD into the complete building process (structural, mechanical, civil and architectural) is therefore seen to be the single most important feature for any construction project.

3.0 RANGE OF CAPITAL COSTS AND FEATURES

3.1 RANGE OF CAPITAL COSTS

While CAD is rapidly becoming an integral part of the design and construction field, it still requires considerable capital expense and time. Setting up a computer aided graphics systems costs anywhere from $50,000 to cover 500,000, depending on the features desired and number of workstations required. It could take anywhere from three to twelve months after delivery of a system based on normal start-up time, implementation and training to make a system operate.

3.2 FEATURES - GRAPHICS AND NON-GRAPHICAL DATA

The basic technique used by all CAD systems is similar to manual, overlay drafting or pin bar registration.

Using the principles of overlay drafting, computer graphics provides the flexibility to manipulate design elements freely by the inclusion and exclusion of layers with each of the building subsystems assigned to a particular layer. Conflicts in design elements can be easily spotted simply by stacking the overlays (e.g. ductwork, plumbing, structural) and assigning minimum and maximum heights for each component.

When comparing CAD systems in the same price range, it can be expected that the manipulation and input of graphics is comparable and that the degree of versatility may vary. Generally, CAD/CAM systems in the upper end price range provide capabilities for mirroring, altering scale, repeating symbols, line style creation, automatic dimensioning, and a host of other functions.

The major variance occurs in the structure of the systems data base and method of dealing with non-graphical (i.e. text) data.

The ability to link graphical symbols with non-graphical information is the key factor in revolutionizing the construction industry. Sophisticated softwear now exists where drawings can be searched and a bill of materials produced. Wall assemblies and windows can be given "U" valves and heat load calculations generated. ULC ratings can be assigned to a particular detail or assembly for recall when required. Specifications, packages and schedules can be automatically generated.

It is this method of assigning non-graphical data to graphics which will allow a computer to analyze and sort an array of information accumulated on working drawings, in whatever fashion required, by estimators, contractors, building departments, owners, and property/facility managers.

4.0 CAD SYSTEMS OVERVIEW

4.1 LOW COSTS ($30,000 OR LESS)

Due to price limitations, systems in this category are based on micro computer technology (Apples, IBM P.C., etc.). This places severe restrictions on memory capacity of both the computer and disc.

A major restriction in this price range has been a maximum drawing size of only 11" x 17". Large plotters are now becoming available. Letter size details, storing of standard shapes, calculations of areas or tasks where minor variations are required to drawings, are ideally suited for these systems.

The software (program) generally has the ability to handle simple geometric construction (circles, arcs, polygons). As more sophisticated operations are required, the program increases in size, which in turn occupies more space in storage.

These systems are ideally suited to smaller offices not wishing to be left behind in an advancing technology.

4.2 MEDIUM COST ($30,000 TO $100,000)

These systems are considerably more powerful and have the ability to store larger numbers of drawings of greater complexity.

Some systems which fall into this category are 'stand alone' (i.e. a central C.P.U. is not required). Although they allow for menu creation, large operations are cumbersome to implement. With some systems it becomes difficult to transfer entities from one layer to another. Although non-graphical data can be stored, this tends to cause large files, thus slowing down the system.

4.3 HIGH COST ($100,000 AND UP)

Improved speed, accuracy and programming flexibility dominate CAD systems in this category. Most high end systems offer a full range of programs supplementing the basic graphics (e.g. reinforced concrete detailing, space planning, mapping, etc.). Additionally, these programs run on very powerful computers which in turn offer other programs (accounting, critical path, etc.).

Most CAD systems in this price range are customized to the user's needs. They offer a wide range of C.P.U.'s graphic workstations, and plotters. Flexibility becomes an integral part of the user's growth projections.

5.0 CAD SYSTEM EVALUATION

The information contained in this evaluation was obtained directly from manufacturers and suppliers through inquiries made during our in-house selection process, and experience gained through actual hands on experience of the equipment in question.

The three systems are evaluated on a two workstation configuration, ranging in price from $120,000 to $250,000. While every precaution has been taken to ensure that the following is accurate and comprehensive, we cannot accept responsibility for errors or omissions which may result due to suppliers' literature and demonstrations.

5.1 APPLIED RESEARCH OF CAMBRIDGE 'GDS' (GENERAL DRAFTING SYSTEM)

5.1.1 Hardware

'GDS" software has been written to run on standard DEC-VAX and PRIME, Central Processing Unit. These are 32 bit technology C.P.U.'s offering a wide range of processing capacity, directly related to cost.

The basic C.P.U. configuration is a PRIME 2250 or VAX 11/730, with main memory capacity of 3/4 to 2 megabytes and a storage capacity of 68 to 158 megabytes. Archiving and storage of drawings is handled on 1/4" magnetic tapes, capable of holding 15 megabytes of information (approximately 20 fairly complex, E size drawings). This process is generally slow, but can be rectified by updating the taping system.

Tektronics graphic workstations are normally used with this system, however, a variety of other manufacturers are supported. Black and white raster terminals, high resolution colour terminals, and vector storage terminals are available.

Plotters capable of handling 'E' size drawing sheets in wet ink or electrostatic are available. The Calcomp 960 Vinseteck plotters are supported.

Peripheral devices for Xerox type reproduction of screen displays (not to Scale) printers and digitizers are supported.

5.1.2 Software

The software (GDS) is a two dimensional drafting system with a three dimensional visualization module sold as an option to GDS.

Dialogue with the program is executed through a menu interfacing with a four button cursor and digitizer tablet. Menus can be displayed via the graphic screen or fixed tablet. Up to 2,000 objects or layers can be created.

5.1 (cont'd)

5.1.2 Software (cont'd)

Basic drawing operations are carried out using a comprehensive range of line drawing capabilities, geometric construction and drafting symbols. This selection of geometric construction is extremely comprehensive and encompasses a full range of Euclidian construction.

Automatic dimensions, a full range of sectional properties (i.e. area, perimeter, moment of inertia), arbitrary data capabilities, along with an extensive library of line styles, character styles and symbols, are standard with this system.

5.1.3 Conclusions

The GDS (General Drafting System) is a powerful program allowing the operator to set up his or her own environment through implementation of user defined menus and macros. Through GDS generated basic programs, the user can access the data base and manipulate information in whatever form necessary (i.e. costing/ estimating/inventory).

The complexity of the system is more demanding on operator skills and is therefore sometimes seen as a deterrent. Its ability to support a variety of hardware and its thorough software package, are seen in its strong points.

Future enhancements include micro computer systems and "real time" three dimensional modelling.

5.2 IBM 'FASTDRAFT'

5.2.1 Hardware

Fastdraft utilizes an IBM C.P.U. based on a 16 bit technology.

The C.P.U. configuration is 256K main memory capacity and 14 megabytes storage capacity. Storage and archiving of drawings involves use of floppy discs and requires strict administration. The 14 megabyte storage capacity could be sufficient with judicious off-line storage (floppy disc) however, the main memory would require upgrade if additional programs were required.

As an offshoot of IBM's turnkey system, the management of the operating system is quite minimal. Single switch on/off will power and boot the system.

Graphic workstations are again IBM. They are monochromatic raster screens of medium resolution 20" x 26". The large screen size offers an advantage on large drawings. The input of graphics through light pen interface is a subjective issue and has been found by some users to be physically tiring.

5.2 (cont'd)

The HP 75808 (Hewlett Packard - D Size) plotter is presently supported by this system. The eight pen reservoir might seem excessive, however, the technology performance records of this plotter are impressive. The limitations of a 'D' size sheet are restrictive to most firms and should be considered carefully.

Peripheral devices such as hard copy units and digitizers are not yet supported by IBM. Check plots must therefore be handled at the plotter.

5.2.2 Software

The software is a two dimensional drafting system dialogue with the program executed through three menus. The 'main menu' is used for drawing administration (deleting, merging, creating). The 'custom menu' is used for drawing parameters (scale, units, unistyle, etc.). The 'edit' menu is used for graphic. Data is input is through a light pen placed physically against the screen by the operator.

As in most systems of this price range, mirroring, rotating scale, automatic dimensioning, etc., are available. Automatic dimensioning is in imperial or metric, however, conversion is not available.

The task of repeating components from a library is simple, however, the user cannot stipulate scale and rotation of repeated objects. Workstations cannot access a common library and each workstation must have its own library or a copy of the library.

Continuous plotting appears weak. The user must create plots on an individual basis, therefore, if a job consists of one drawing per floppy disc, each plot requires dumping that disc into the system and repeating the procedure for the next plot. Having a holding area (plot queue) so that continuous plotting can be performed with manual external procedures is preferable.

The system can be made interactive with an IBM Personal computer, making additional software available to the users (e.g. accounting, scheduling, etc.).

5.2.3 Conclusions

The IBM Fastdraft system appears to be simple to learn and operate. However, users are unable to customize their environmental perimeters (e.g. line creation, menu creation, etc.). The program itself is in its early stages and requires additional enhancements.
It does, however, offer sophisticated graphical procedures (e.g. repeating components on a line or circle, dimensioning to the centre of circles, etc.).

Plotting a large quantity of drawings (50 or more) could represent a major in-house scheduling problem as workstations should be inactive in order for the plotter to operate at full speed and efficiency.

5.2 (cont'd)

5.2.3 Conclusions (cont'd)

No clear documented picture of IBM's future enhancements or developments are available. Any that are in programs are considered confidential by IBM. Clear, concise documentation of these enhancements should be made available to potential buyers.

5.3 INTERGRAPH

5.3.1 Hardware

The system is based on a DEC VAX line of processors. Intergraph add substantially to the hardware to make the system capable of handling graphics at speed. A 32 bit technology is utilized in the operating system.

The C.P.U. system typically consists of 2 megabytes main memory and 84 megabytes of storage. Archiving and storage is handled on 9 track 800/1600 BPI 125 IPS tape.

The largest, most powerful workstation offered by Intergraph is the 'Interact'. This is a standard dual screen workstation, available as a high density colour or sono cromatic screen. The station has three local processors (display processor, view processor and motorola 68000 C.P.U.). It is estimated that the local processors handle one third of all operations in a typical work session.

Interpro and Interview are two additional workstations available by Intergraph, but are lower end units.

The HP 7580 (Hewlett Packard) 'E' size plotter is supported by Intergraph. Peripheral devices such as printers and digitizer tablets are also available.

5.3.2 Software

This system is a two dimensional drafting system with a three dimensional module option available.

Dialogue with the program is executed through a menu, interfacing with a 4 to 12 button cursor and digitizing tablet. IDGS allows drawings to be created with up to 63 layers. In addition, three more drawing files can be accessed to provide up to 252 layers. These additional files, however, can only be opened for read access.

IGDS (international Graphic Design Software) offers a comprehensive set of design and drafting functions. DMRS (Data Management and Retrieval Systems) manages text and descriptive information associated with graphics. One functional constraint with the data

5.3 (cont'd)

5.3.2 Software (cont'd)

base is that all description fields to be associated with graphic symbols have to be established at the outset. If the user wishes to extend the number of fields for a particular symbol, it is necessary to rebuild the data base.

For multiple occurrences of the same graphics, all data and coordinates are repeated. Some systems utilize reference positions only and therefore minimize the storage capacity of the C.P.U. There is research currently being undertaken at Intergraph to overcome this problem.

Another problem precipitated by the file structure appears in the drawing storage requirements. Disc space is allocated at the start of a drawing operation (usually default). This procedure is extremely inefficient, and results in Intergraph system usually being configured with larger disc systems than competitors.

5.3.3 Conclusion

Intergraph is a powerful system capable of generating most geometrical figures and shapes. Hardware restrictions imposed due to the software structure have made the system costly.

Operator creativity is not limited in that menus and line styles, etc., are pre-defined.

6.0 EQUIPMENT SELECTION PROCESS

6.1 CAPABILITIES OF LARGE SYSTEMS VS. SMALL

The primary advantages of large central processing units and a sophisticated software program are speed and versatility.

Computer response time will vary proportionately to the number of users accessing the system at any particular time, and the processor's memory capacity. The greater the demand for output and processing, the slower the response time. Smaller C.P.U.'s are also restricted to software program size, and the physical number of parts available at the rear of the C.P.U.

Software or smaller C.P.U.'s generally tend to omit certain functions such as menu and line style operation, thus reducing the burden on the C.P.U. This restriction limits the user's production capabilities.

6.2 QUALITY OF OUTPUT AND FINAL COSTS

Through present technological advances, graphic reproduction from CAD systems are handled in three basic formats. Hard copy units are available for Xerox type reproduction and are generally of lower quality, non-reproducible and not to scale. They cost approximately $12,000. Plotters in a variety of sizes for accurate reproduction in wet ink and ball point pens or markers range from $15,000 to $55,000. Electrostatic plotters are substantially more expensive ($80,000-$100,000), but still lack density in line definition.

All of the above can be installed at remote locations and connected to a central C.P.U. by a modem and a designated telephone line. Modems range from $1,000 to $2,000 whereas the costs of designated lines vary with distance, speed of transmission and clarity.

Alternately, Factcom equipment also utilizing Xerox type reproduction are available at low cost of approximately $6,000-$7,000. This type of equipment operates similarly to a Xerox process, however, it allows out-put at remote locations; again, not to scale, and limited in size. Output of the above products vary substantially and selection should be determined by the user requirements (i.e. reference output or reproducible output).

6.3 CAPITAL COST AND MAINTENANCE

Capital cost of systems vary with the quantity of workstations required. Licensing by quantity of workstations is a generally accepted standard.

Maintenance costs associated with software, and hardware should be considered when purchasing a system.

6.4 UPDATING EQUIPMENT

Updating of equipment is generally an expensive proposition unless the equipment has been initially installed with expansion capabilities (i.e. additional memory board rather than a new C.P.U.).

7.0 DETAIL LIBRARY & DATA BANK UTILIZATION

INTRODUCTION

Standard details and detail libraries, though not a result of the computer age, have resulted in substantial savings to the production of working drawings in most architectural practices. Development of detail libraries on letter size paper and assembled into a larger drawing format by use of photography, has become standard practice in the architectural community.

The advantages of a standard library are self evident. Upgrading details when proven on-site, reproductions and minor alterations to accommodate new details, and consistency in office standards, have resulted in a more efficient product in a shorter period of time. As the detail library increases, checking and drawing time is reduced, thus allowing additional time for new detail development.

With the advent of the computer and CAD systems, standard detail libraries can be developed in shorter periods of time due to the ease in which elements can be deleted or altered. Accurate input of graphical data and non-graphical data can be transferred from one detail to another, and multiple originals can be produced with no reduction in quality or scale.

Utilization of a data bank of standard details can be made accessible through categorization of details by component name and technical data of a particular assembly. Using the computer's ability to search components or assemblies, all relevant details can be recalled.

7.1 STANDARD DETAIL LIBRARY DATA BANK

The establishment of a Central Data Bank of proven standard details is a significant concept and a trend that with the aid of computers, will inevitably occur in the Architectural industry. An accumulation of proven, acceptable details within the industry exist in a multitude of private practices and government agencies.

Standard details minimize design and drafting costs and reduce errors and omissions in detailing and checking; the natural progression is to limit fragmentation and provide quality, proven details acceptable to participating firms and regulatory agencies. It is unlikely, however, that the Architectural industry will, within itself, establish a mechanism to make available standard details to competitive firms. It is therefore evident that the development of such a resource will occur within the manufacturing sector, Service Bureau sector or Government Regulatory Agencies. The latter is the forerunner, as conflict of interest is minimal and development and control is optimal.

Agencies such as CMHC, NRC, CHBA and others who have developed details are logical candidates for such an undertaking. The implementation time and final availability of service would in fact be the determining items in system size.

9.0 MAINTENANCE OF STANDARD LIBRARY

9.1 REVISIONS TO DETAILS

Revisions to details is generally an ongoing process. Constant maintenance due to changes in materials and methods of construction are required in all librar·es. It is necessary therefore to accurately monitor details and assign suitable staff to the chore of updating details. In addition, administration suitable to update users must be provided.

9.2 INPUT OF NEW DETAILS

Constant investigation of methods and materials is required in order to maintain a library bank. User input regarding requirements and development can be utilized to supplement in house resea ch.

10.0 ANTICIPATED FUTURE DEVELOPMENTS

10.1 HARDWARE

Recent forecasts predict that increases in speed, capacity, reliability and reductions in size and costs can be expected to continue into the 1990s. These continued improvements will result from advances in component technology, particularly in areas of integrated circuits, new types of memory devices, and from the introduction of computers in architecture.

It is unlikely that the cost of peripheral devices (plotters, printers, etc.) will reduce in cost as significantly as that of C.P.U s and memory capacity, but even so, there is no doubt that computers are becoming as available as television sets. With new advances in laser technology and electrostatic plotters, it is difficult to predict the future, let alone costs of mechanical peripheral devices.

10.2 SOFTWARE

The single most important future development in the CAD software industry is three dimensional modelling with data analysis capabilities. Very expensive software exists today that allows the user to set up a wall-masonry veneer, structural open web steel joists, etc. Wi h this information, the data base, automatic generation of plans, sections and details can be executed by the program.

Consequently, reports in any format can be generated by the computer (i.e. heat loss/gain calculations, cost estimating, etc.)

10.3 COMMUNICATIONS

Data can be transmitted between terminals and the computer via communication channels. This implies the possibility of a sophisticated nationwide or even worldwide information utility at any telephone. CAD software suppliers will take advantage of this network system and produce programs so as to allow communications to take place between one CAD system and another. As an example, McAuto (McDonald Douglas Automations) have developed a program allowing transfer of drawings from an Intergraph system to a 'QDS' system, along with related object names and arbitrary data.

APPENDIX B

A SUMMARY OF PROJECT METHODOLOGY AND FINDINGS

1.0 INFORMATION ASSEMBLY

Information for this project came from four sources:

1. results of a mail-out questionnaire
2. from personal interviews with selected questionnaire respondents
3. from published materials
4. from the consulting team's project files

The basis of the mailing list was LEBAC and SESCI membership lists and the R-2000 program participants. To these were added names from the consultants' files. A cross-Canada telephone survey was made of regional conservation and renewable energy centres, provincial energy and housing ministries, local utilities and other agencies to expand the list of active energy efficient designer/builders. The result was a mailing list of 712* names of designers, builders, architects and engineers known to have an interest in the low energy housing field.

A questionnaire was developed which was intended to identify the types of insulated assemblies preferred by practitioners in the field and to provide the library of building sections and details which would form the basis for the evaluation and selection procedure. The questionnaire was pre-tested on in-house systems and the project team's completed questionnaires were added to the library and have been included in the findings. The French version of the questionnaire was mailed to Quebec addresses only. A postcard reminder was mailed out three weeks after the initial mailing to enhance the response rate. During this period, a search of the current literature was made to identify additional building systems and details to add to the library. Where possible, a questionnaire was completed for the building systems found; individual details were coded and added to the catalog described below.

1.1 INTERVIEWS

Interview candidates were selected for each of the above grade wall systems identified. In general, those selected were active practitioners who had built 10 or more units and had tried techniques in addition to their preferred system. The interview objectives were to record the deviations from standard construction procedures for each system so that site-related factors might be evaluated, and to gather as many pertinent detail drawings as practical to expand the data base. The interview records are given in Appendix 2.

*At time of initial mailing, March 2, 1984, and excluding 800 the consultants) and 900 (written sources) series entries.

2.0 QUESTIONNAIRE FINDINGS

2.1 160 returned were received representing a response rate of about 22% of 114 which included systems information. All regions of Canada were represented, the greatest number of returns from Ontario and Quebec.

Table I Frequency of Completed Returns By Region

Region	Complete With Drawings	Partially Complete	Total
B.C., Yukon & NWT	12	5	17
Prairies	22	8	30
Ontario & Quebec	28	22	50
Atlantic	7	10	17
	69	45	114

2.2 Of the 114 responding practitioners, the majority, 69, reported construction as a major activity. Design was the next most frequently reported activity, 34. 31 companies were engaged in both design and construction.

Table II Major Company Activities

	Construction	Design	Engineering	Architecture	Other	All	
Construction	39	21	1	2	6	X	69
Design	21	3	3	2	5	X	34
Engineering	1	3	1	1	X	X	6
Architecture	2	2	1	4	1	X	10
Other	6	5	X	1	10	X	22
All	X	X	X	X	X	10	10

2.3 In response to Questions 6 and 7, the respondents reported designing or building a total of 6,634 housing units since the spring of 1982 of which 5,220 were described as being energy efficient. Disregarding 3,800 units claimed by one contractor, the number of energy efficient units was 1,420.

2.4 FIRST USE OF DOCUMENTED FRAMING SYSTEMS

Respondents were asked to document one framing system which they had used in the past and which they intended to use again. The 114 respondents who did so, reported building a total of 1796 units using the documented systems. The majority of systems were adopted after 1980. Only 20 respondents reported using their system in the 1970's.

Table IV Year System First Used

Year	Frequency
Pre 1975	2
1975-1979	18
1980	12
1981	13
1982	24
1983	29
	98

2.5 In response to Question 12 'For which details have you found good solutions', the majority were satisfied with their details for sills, electrical wiring and windows. Not surprisingly, only 5 had good solutions for party walls. Few reported good solutions for garages. chimneys and cantilevers. Good eave solutions were reported by 36 respondents which was considered to be a relatively low number.

Table III 'For Which Details Have You Found Good Solutions?'

	Frequency							
Detail	70	60	50	40	30	20	10	1
Garage/house foundation junction						26		
Sill plates & first floor headers	71							
Masonry party wall edge conditions								5
Floors over unheated spaces					36			
Electrical wiring	72							
Exterior door openings				44				
Second floor headers			55					
Chimneys						25		
Window openings	75							
Eaves					36			
Plumbing vents				49				
Electrical entrance					32			
Cantilevers						29		
Floors					31			

2.6 BUILDING SYSTEMS

Building systems were classified by above grade wall type, below grade wall type and roof type. The frequency of the various types is presented in Table V.

2.6.1 Above Grade Wall Systems

Table VI ranks the occurrence of the various systems.

The most common system was single stud, 526 units. The next most frequently used system was double frame, interior wall loadbearing, code II, 442 units. However 374 of these were built by one agency, the Manitoba Housing and Renewal Corporation.

The majority of practitioners gave no indication of dissatisfaction with the techniques they documented. But, from informal comments offered it was apparent that at least some builders were dissatisfied to some extent with their current systems and intended to try alternative systems. Systems to be tried included double frame, exterior wall loadbearing, single stud with interior insulating sheathing and single stud with exterior insulating sheathing.

Table VI Ranked Occurrence of Above Grade Wall Types

526	Single stud, insulating sheathing
442	Double frame, interior loadbearing
334	Single stud, wrap & strap
125	'Insul wall'*
119	Standoff systems
59	Single stud, interior strapping
40	Single stud, interior insulating sheathing
33	Double frame, exterior loadbearing
30	Expanded stud
2	Single stud, sprayed polyurethane
(36	Single stud, conventional)

*Contributed by the manufacturer

Table V Frequency of Drawings & Housing Units By System Type

	Code	Respondents Submitting Drawings	# Units Represented By Drawings	Other Units	Total Units
ABOVE GRADE WALLS					
Single stud, insulating sheathing		10	146	380	526
Single stud, wrap & strap 2" cavity		2	20	7	27
Single stud, wrap & strap 3" cavity		12	27	280	307
Single stud, interior strapping		11	97	9	106
Single stud		4	35	1	36
'Insulwall'		1	125	0	125
Single stud, interior wrap & strap		1	40	0	40
Single stud, sprayed polyurethane		1	2	0	2
Double frame, int. load bearing		6	401	41	442
ext. load bearing		7	32	1	33
Double frame, standoff other		3	6	65	71
'Larson' truss		7	46	0	46
'Le Clair'		1	46	0	46
Expanded stud		3	2	0	2
			30	0	30
TOTAL		69	1055	784	1839
BELOW GRADE WALLS					
Concrete, exterior insulation		15	579	255	834
Concrete, interior insulation		23	174	303	477
Concrete, exterior and interior insulation		5	15	21	36
Insulated blocks 'sparfill'		1	15	0	15
Foam form		0			
P.W.F. double wall		2	6	0	6
P.W.F. on concrete footings		4	46	0	46
P.W.F. grade beam		1	6	0	6
P.W.F. on crushed stone		9	48	208	256
Uninsulated		6	92	1	93
TOTAL		66	981	788	1769
ROOFS					
W truss, raised heel		48	900	548	1448
W truss, dropped bottom cord		0	0	63	63
Scissors truss		3	1	0	1
Parallel cord truss		1	7	0	7
Parallel cord truss, site built		1	6	0	6
Rafter		1	1	0	1
Rafter with purlins		6	13	155	168
Double rafter and purlins		4	38	1	39
W truss standard		1	2	0	2
TOTAL		1	10	21	31
		66	978	788	1766

2.6.2 Below Grade Wall Systems

Concrete foundations with exterior insulation were most frequently used, 834 units. Interior insulation accounted for 477 units, preserved wood foundations were used on 314 units. 93 foundations were uninsulated and occurred in conjunction with insulated wood floors. In 36 cases builders had applied both exterior and interior insulation.

2.6.3 Roof Systems

The overwhelming majority of houses were built with raised heel trusses 1449 units. Dropped bottom cord trusses were used in 63 units.

3.0 DRAWINGS SUBMITTED

A total of 260 drawings were submitted by 69 respondents. These drawings represented 28 different locations, of which sills and eaves were most frequently included. The occurrence of drawings is given in Table VIII. A summary of frequencies is contained in Table VII.

Table VII Frequent Detail

# of Drawings	Detail
63	Sill
57	Eave
33	Window and door openings
31	Intermediate floors
20	Footings
13	Pipe or vent penetrations
8	Electrical penetrations
6	Chimney

Table VIII Occurrence of Drawings

JUNCTION	01	sill AGW/BGW	63
	02	heated/unheated BGW	2
	03	BGW/IF	20
	06	intermediate floors	31
	07	heated/unheated AGW	5
	08	AGW/IF cantilever	5
	09	AGW/IF unheated/heated	1
	10	eave AGW/RF	57
	11	gable AGW/RF	5
	13	shed roof/AGW intersection	2
	14	split level ceiling	3
	15	insulated wall, int. partition	2
	16	insulated ceiling, int. partition	1
	19	party wall	3
OPENING	21	BGW window	2
	22	AGW window	24
	23	RF skylight	1
	25	AGW door, single	5
	26	AGW door patio/sliding/french	1
PENETRATION	31	Pipe or plumbing vent BGW	1
	32	" " " AGW	4
	33	" " " RF	4
	34	" " " non-specific	4
	35	Flue or chimney AGW	2
	36	" " RF	4
	45	Electrical service panel	1
	47	" outlets AGW	4
	48	" outlets RF	3